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(54) Title: GROWTH-HORMONE SECRETAGOGUES

#### (57) Abstract

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This invention is directed to compounds of formula (I) and the pharmaceutically-acceptable salts thereof, where the substituents are as defined in the Specification, which are growth hormone secretagogues and which increase the level of endogenous growth hormone. The compounds of this invention are useful for the treatment and prevention of osteoporosis, congestive heart failure, frailty associated with aging, obesity; accelerating bone fracture repair, attenuating protein catabolic response after a major operation, reducing cachexia and protein loss due to chronic illness, accelerating wound healing, or accelerating the recovery of burn patients or patients having undergone major surgery; improving muscle strength, mobility, maintenance of skin thickness, metabolic homeostasis or renal homeostasis. The compounds of the present invention are also useful in treating osteoporosis when used in combination with: a bisphosphonate compound such as alendronate; estrogen, premarin, and optionally progesterone; an estrogen agonist or antagonist; or calcitonin, and pharmaceutical compositions useful therefor. Further, the present invention is directed to pharmaceutical compositions useful for increasing the endogenous production or release of growth hormone in a human or other animal which comprises an effective amount of a compound of the present invention and a growth hormone secretagogue selected from GHRP-6, Hexarelin, GHRP-1, growth hormone releasing factor (GRF), IGF-1, IGF-2 or B-HT920. The invention is also directed to intermediates useful in the preparation of compounds of formula (1).

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WO 97/24369 PCT/IB96/01353

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## GROWTH-HORMONE SECRETAGOGUES

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This invention relates to dipeptide compounds which are growth hormone secretagogues and are useful for the treatment and prevention of osteoporosis.

#### Background of the Invention

Growth hormone (GH), which is secreted from the pituitary gland, stimulates growth of all tissues of the body that are capable of growing. In addition, growth hormone is known to have the following basic effects on the metabolic process of the body:

- Increased rate of protein synthesis in substantially all cells of the body;
- 2. Decreased rate of carbohydrate utilization in cells of the body:
- Increased mobilization of free fatty acids and use of fatty acids for energy.

Deficiency in growth hormone results in a variety of medical disorders. In children, it causes dwarfism. In adults, the consequences of acquired GH deficiency include profound reduction in lean body mass and concomitant increase in total body fat, particularly in the truncal region. Decreased skeletal and cardiac muscle mass and muscle strength lead to a significant reduction in exercise capacity. Bone density is also reduced. Administration of exogenous growth hormone has been shown to reverse many of the metabolic changes. Additional benefits of therapy have included reduction in LDL cholesterol and improved psychological well-being.

In cases where increased levels of growth hormone were desired, the problem was generally solved by providing exogenous growth hormone or by administering an agent which stimulated growth hormone production and/or release. In either case the peptidyl nature of the compound necessitated that it be administered by injection. Initially the source of growth hormone was the extraction of the pituitary glands of cadavers. This resulted in an expensive product, and carried with it the risk that a disease associated with the source of the pituitary gland could be transmitted to the recipient of the growth hormone (e.g., Jacob-Creutzfeld disease). Recently, recombinant growth hormone has become available which, while no longer carrying any risk of disease transmission, is still a very expensive product which must be given by injection or by a nasal spray.

Most GH deficiencies are caused by defects in GH release, not primary defects in pituitary synthesis of GH. Therefore, an alternative strategy for

normalizing serum GH levels is by stimulating its release from somatotrophs. Increasing GH secretion can be achieved by stimulating or inhibiting various neurotransmitter systems in the brain and hypothalamus. As a result, the development of synthetic growth hormone-releasing agents to stimulate pituitary GH secretion are being pursued, and may have several advantages over expensive and inconvenient GH replacement therapy. By acting along physiologic regulatory pathways, the most desirable agents would stimulate pulsatile GH secretion, and excessive levels of GH that have been associated with the undesirable side effects of exogenous GH administration would be avoided by virtue of intact negative feedback loops.

Physiologic and pharmacologic stimulators of GH secretion include arginine, L-3,4-dihydroxyphenylalanine (L-DOPA), glucagon, vasopressin, and insulin induced hypoglycemia, as well as activities such as sleep and exercise, indirectly cause growth hormone to be released from the pituitary by acting in some fashion on the hypothalamus perhaps either to decrease somatostatin secretion or to increase the secretion of the known secretagogue growth hormone releasing factor (GHRF) or an unknown endogenous growth hormone-releasing hormone or all of these.

Other compounds have been developed which stimulate the release of endogenous growth hormone such as analogous peptidyl compounds related to GRF or the peptides of U.S. Patent 4,411,890. These peptides, while considerably smaller than growth hormones are still susceptible to various proteases. As with most peptides, their potential for oral bioavailability is low. WO 94/13696 refers to certain spiropiperidines and homologues which promote release of growth hormone. Preferred compounds are of the general structure shown below.

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WO 94/11012 refers to certain dipeptides that promote release of growth hormone. These dipeptides have the general structure

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where L is

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The compounds of WO 94/11012 and WO 94/13696 are reported to be useful in the treatment of osteoporosis in combination with parathyroid hormone or a bisphosphonate.

#### Summary of the Invention

5 This invention provides compounds of the formula:

the racemic-diastereomeric mixtures and optical isomers of said compounds and the pharmaceutically-acceptable salts and prodrugs thereof,

10 wherein

e is 0 or 1:

n and w are each independently 0, 1 or 2, provided that w and n cannot both be 0 at the same time;

Y is oxygen or sulfur;

15 R<sup>1</sup> is hydrogen, -CN, -(CH<sub>2</sub>)<sub>q</sub>N(X<sup>6</sup>)C(O)X<sup>6</sup>, -(CH<sub>2</sub>)<sub>q</sub>N(X<sup>6</sup>)C(O)(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>, -(CH<sub>2</sub>)<sub>q</sub>N(X<sup>6</sup>)SO<sub>2</sub>X<sup>6</sup>, -(CH<sub>2</sub>)<sub>q</sub>N(X<sup>6</sup>)C(O)N(X<sup>6</sup>)(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>, -(CH<sub>2</sub>)<sub>q</sub>N(X<sup>6</sup>)C(O)N(X<sup>6</sup>)(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>, -(CH<sub>2</sub>)<sub>q</sub>C(O)N(X<sup>6</sup>)(X<sup>6</sup>), -(CH<sub>2</sub>)<sub>q</sub>C(O)N(X<sup>6</sup>)(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>, -(CH<sub>2</sub>)<sub>q</sub>C(O)OX<sup>6</sup>, -(CH<sub>2</sub>)<sub>q</sub>C(O)O(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>, -(CH<sub>2</sub>)<sub>q</sub>OX<sup>6</sup>, -(CH<sub>2</sub>)<sub>q</sub>OC(O)X<sup>6</sup>, -(CH<sub>2</sub>)<sub>q</sub>OC(O)(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>, -(CH<sub>2</sub>)<sub>q</sub>OC(O)N(X<sup>6</sup>)(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>, -(CH<sub>2</sub>)<sub>q</sub>OC(O)N(X<sup>6</sup>), -(CH<sub>2</sub>)<sub>q</sub>C(O)X<sup>6</sup>, -(CH<sub>2</sub>)<sub>q</sub>C(O)(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>, -(CH<sub>2</sub>)<sub>q</sub>N(X<sup>6</sup>)C(O)OX<sup>6</sup>, -(CH<sub>2</sub>)<sub>q</sub>C(O)X<sup>6</sup>, -(CH<sub>2</sub>)<sub>q</sub>C(O)(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>, -(CH<sub>2</sub>)<sub>q</sub>S(O)<sub>m</sub>X<sup>6</sup>, -(CH<sub>2</sub>)<sub>q</sub>S(O)<sub>m</sub>(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>,

 $-(C_1-C_{10})alkyl, -(CH_2)_t-A^1, -(CH_2)_q-(C_3-C_7)cycloalkyl, -(CH_2)_q-Y^1-(C_1-C_6)alkyl,$ 

 $-(CH_2)_q - Y^1 - (CH_2)_t - A^1 \text{ or } -(CH_2)_q - Y^1 - (CH_2)_t - (C_3 - C_7) cycloalkyl;$ 

where the alkyl and cycloalkyl groups in the definition of  $R^1$  are optionally substituted with  $(C_1-C_4)$ alkyl, hydroxyl,  $(C_1-C_4)$ alkoxy, carboxyl, -CONH<sub>2</sub>, -S(O)<sub>m</sub>(C<sub>1</sub>-C<sub>6</sub>)alkyl, -CO<sub>2</sub>(C<sub>1</sub>-C<sub>4</sub>)alkyl ester, 1H-tetrazol-5-yl or 1, 2 or 3 fluoro;  $Y^1$  is O, S(O)<sub>m</sub>, -C(O)NX<sup>6</sup>-, -CH=CH-, -C=C-, -N(X<sup>6</sup>)C(O)-, -C(O)NX<sup>6</sup>-, -C(O)O-, -OC(O)N(X<sup>8</sup>)- or -OC(O)-;

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q is 0, 1, 2, 3 or 4;

t is 0, 1, 2 or 3;

said  $(CH_2)_q$  group and  $(CH_2)_t$  group may each be optionally substituted with hydroxyl,  $(C_1-C_4)$ alkoxy, carboxyl,  $-CONH_2$ ,  $-S(O)_m(C_1-C_6)$ alkyl,

5 - $CO_2(C_1-C_4)$ alkyl ester, 1H-tetrazol-5-yl, 1, 2 or 3 fluoro, or 1 or 2 ( $C_1$ - $C_4$ )alkyl;

 $R^2$  is hydrogen,  $(C_1-C_8)$ alkyl,  $-(C_0-C_3)$ alkyl- $(C_3-C_8)$ cycloalkyl,  $-(C_1-C_4)$ alkyl- $A^1$  or  $A^1$ ; where the alkyl groups and the cycloalkyl groups in the definition of  $R^2$  are optionally substituted with hydroxyl,  $-C(O)OX^6$ ,  $-C(O)N(X^6)(X^6)$ ,  $-N(X^6)(X^6)$ ,

 $\begin{array}{lll} -S(O)_m(C_1-C_6)alkyl, -C(O)A^1, -C(O)(X^6), CF_3, CN \ or \ 1, \ 2 \ or \ 3 \ halogen; \\ R^3 \ is \ A^1, \ (C_1-C_{10})alkyl, \ -(C_1-C_6)alkyl-A^1, \ -(C_1-C_6)alkyl-(C_3-C_7)cycloalkyl, \\ -(C_1-C_5)alkyl-X^1-(C_1-C_5)alkyl, \ -(C_1-C_5)alkyl-X^1-(C_0-C_5)alkyl-A^1 \ or \\ -(C_1-C_5)alkyl-X^1-(C_1-C_5)alkyl-(C_3-C_7)cycloalkyl; \end{array}$ 

where the alkyl groups in the definition of R<sup>3</sup> are optionally substituted with, -  $S(O)_m(C_1-C_8)$  alkyl, - $C(O)OX^3$ , 1, 2, 3, 4 or 5 halogens, or 1, 2 or 3  $OX^3$ ;  $X^1$  is O,  $S(O)_m$ , - $N(X^2)C(O)$ -, - $C(O)N(X^2)$ -, -OC(O)-, -C(O)O-, - $CX^2=CX^2$ -, - $N(X^2)C(O)O$ -, - $OC(O)N(X^2)$ - or -C=C-:

R<sup>4</sup> is hydrogen, (C<sub>1</sub>-C<sub>6</sub>)alkyl or (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl, or R<sup>4</sup> is taken together with R<sup>3</sup> and the carbon atom to which they are attached and form (C<sub>5</sub>-C<sub>7</sub>)cycloalkyl, (C<sub>5</sub>-C<sub>7</sub>)cycloalkenyl, a partially saturated or fully saturated 4- to 8-membered ring having 1 to 4 heteroatoms independently selected from the group consisting of oxygen, sulfur and nitrogen, or is a bicyclic ring system consisting of a partially saturated or fully saturated 5- or 6-membered ring, fused to a partially saturated, fully unsaturated or fully saturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen;

 $X^4$  is hydrogen or  $(C_1-C_6)$ alkyl or  $X^4$  is taken together with  $R^4$  and the nitrogen atom to which  $X^4$  is attached and the carbon atom to which  $R^4$  is attached and form a five to seven membered ring;

wh re a and b are independ ntly 0, 1, 2 or 3;

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X<sup>5</sup> and X<sup>5a</sup> are each independently selected from the group consisting of hydrogen, trifluoromethyl, A<sup>1</sup> and optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl;

the optionally substituted  $(C_1-C_6)$ alkyl in the definition of  $X^5$  and  $X^{5a}$  is optionally substituted with a substituent selected from the group consisting of  $A^1$ ,  $OX^2$ ,  $-S(O)_m(C_1-C_6)$ alkyl,  $-C(O)OX^2$ ,

 $(C_3-C_7)$ cycloalkyl,  $-N(X^2)(X^2)$  and  $-C(O)N(X^2)(X^2)$ ;

or the carbon bearing  $X^5$  or  $X^{5a}$  forms one or two alkylene bridges with the nitrogen atom bearing  $R^7$  and  $R^8$  wherein each alkylene bridge contains 1 to 5 carbon atoms, provided that when one alkylene bridge is formed then  $X^5$  or  $X^{5a}$  but not both may be on the carbon atom and  $R^7$  or  $R^8$  but not both may be on the nitrogen atom and further provided that when two alkylene bridges are formed then  $X^5$  and  $X^{5a}$  cannot be on the carbon atom and  $R^7$  and  $R^8$  cannot be on the nitrogen atom;

or X<sup>5</sup> is taken together with X<sup>5a</sup> and the carbon atom to which they are attached and form a partially saturated or fully saturated 3- to 7-membered ring, or a partially saturated or fully saturated 4- to 8-membered ring having 1 to 4 heteroatoms independently selected from the group consisting of oxygen, sulfur and nitrogen;

or X<sup>5</sup> is taken together with X<sup>5a</sup> and the carbon atom to which they are attached and form a bicyclic ring system consisting of a partially saturated or fully saturated 5- or 6-membered ring, optionally having 1 or 2 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen, fused to a partially saturated, fully saturated or fully unsaturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen;

 $Z^1$  is a bond, O or N-X<sup>2</sup>, provided that when a and b are both 0 then  $Z^1$  is not N-X<sup>2</sup> or O;

 $R^7$  and  $R^8$  are independently hydrogen or optionally substituted ( $C_1$ - $C_6$ )alkyl; where the optionally substituted ( $C_1$ - $C_6$ )alkyl in the definition of  $R^7$  and  $R^8$  is optionally independently substituted with  $A^1$ , -C(O)O-( $C_1$ - $C_6$ )alkyl,

-S(O)<sub>m</sub>(C<sub>1</sub>-C<sub>6</sub>)aikyl, 1 to 5 halogens, 1 to 3 hydroxy, 1 to 3 -O-C(O)(C<sub>1</sub>-C<sub>10</sub>)aikyl or 1 to 3 (C<sub>1</sub>-C<sub>6</sub>)aikoxy; or

 $\mbox{R}^{7}$  and  $\mbox{R}^{8}$  can be taken together to form -(CH2)r-L-(CH2)r-;

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where L is  $C(X^2)(X^2)$ ,  $S(O)_m$  or  $N(X^2)$ ;

A¹ for each occurrence is independently (C<sub>5</sub>-C<sub>7</sub>)cycloalkenyl, phenyl or a partially saturated, fully saturated or fully unsaturated 4- to 8-membered ring optionally having 1 to 4 heteroatoms independently selected from the group consisting of oxygen, sulfur and nitrogen, a bicyclic ring system consisting of a partially saturated, fully unsaturated or fully saturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen, fused to a partially saturated, fully saturated or fully unsaturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen;

 $A^1$  for each occurrence is independently optionally substituted, in one or optionally both rings if  $A^1$  is a bicyclic ring system, with up to three substituents, each substituent independently selected from the group consisting of F, Cl, Br, I, OCF<sub>3</sub>, OCF<sub>2</sub>H, CF<sub>3</sub>, CH<sub>3</sub>, OCH<sub>3</sub>,  $-OX^6$ ,

-C(O)N(X<sup>6</sup>)(X<sup>6</sup>), -C(O)OX<sup>6</sup>, oxo, (C<sub>1</sub>-C<sub>6</sub>)alkyl, nitro, cyano, benzyl,

 $-S(O)_m(C_1-C_6)alkyl, \quad 1H-tetrazol-5-yl, \quad phenyl, \quad phenoxy, \quad phenylalkyloxy, \\ halophenyl, \quad methylenedioxy, \quad -N(X^6)(X^6), \quad -N(X^6)C(O)(X^6), \quad -SO_2N(X^6)(X^6), \\ \end{pmatrix}$ 

-N(X<sup>6</sup>)SO<sub>2</sub>-phenyl, -N(X<sup>6</sup>)SO<sub>2</sub>X<sup>6</sup>, -CONX<sup>11</sup>X<sup>12</sup>, -SO<sub>2</sub>NX<sup>11</sup>X<sup>12</sup>, -NX<sup>6</sup>SO<sub>2</sub>X<sup>12</sup>,

-NX<sup>6</sup>CONX<sup>11</sup>X<sup>12</sup>, -NX<sup>6</sup>SO<sub>2</sub>NX<sup>11</sup>X<sup>12</sup>, -NX<sup>6</sup>C(O)X<sup>12</sup>, imidazolyl, thiazolyl or tetrazolyl, provided that if A<sup>1</sup> is optionally substituted with methylenedioxy then it can only be substituted with one methylenedioxy;

where  $X^{11}$  is hydrogen or optionally substituted ( $C_1$ - $C_6$ )alkyl;

the optionally substituted  $(C_1-C_6)$ alkyl defined for  $X^{11}$  is optionally independently substituted with phenyl, phenoxy,  $(C_1-C_6)$ alkoxycarbonyl,  $-S(O)_m(C_1-C_6)$ alkyl 1 to 5 halogens, 1 to 3 hydroxy, 1 to 3  $(C_1-C_6)$ alkoxy;

 $X^{12}$  is hydrogen, (C<sub>1</sub>-C<sub>8</sub>)alkyl, phenyl, thiazolyl, imidazolyl, furyl or thienyl, provided that when  $X^{12}$  is not hydrogen,  $X^{12}$  is optionally substituted with one to three substituents independently selected from the group consisting of Cl, F, CH<sub>3</sub>, OCH<sub>3</sub>, OCF<sub>3</sub> and CF<sub>3</sub>;

or  $X^{11}$  and  $X^{12}$  are taken together to form -(CH<sub>2</sub>)<sub>r</sub>-L<sup>1</sup>-(CH<sub>2</sub>)<sub>r</sub>-; L<sup>1</sup> is C(X<sup>2</sup>)(X<sup>2</sup>), O, S(O)<sub>m</sub> or N(X<sup>2</sup>);

r for each occurrence is independently 1, 2 or 3;

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 $X^2$  for ach occurrence is independently hydrogen, optionally substituted ( $C_{1}$ - $C_{6}$ )alkyl, or optionally substituted ( $C_{3}$ - $C_{7}$ )cycloalkyl, where the optionally substituted ( $C_{1}$ - $C_{8}$ )alkyl and optionally substituted ( $C_{3}$ - $C_{7}$ )cycloalkyl in the definition of  $X^2$  are optionally independently substituted with  $-S(O)_m(C_{1}$ - $C_{6}$ )alkyl,  $-C(O)OX^3$ , 1 to 5 halogens or 1 to 3  $OX^3$ ;

X<sup>3</sup> for each occurrence is independently hydrogen or (C<sub>1</sub>-C<sub>6</sub>)alkyl;

 $X^6$  is independently hydrogen, optionally substituted ( $C_1$ - $C_6$ )alkyl, ( $C_2$ - $C_6$ )halogenated alkyl, optionally substituted ( $C_3$ - $C_7$ )cycloalkyl, ( $C_3$ - $C_7$ )-halogenatedcycloalkyl, where optionally substituted ( $C_1$ - $C_6$ )alkyl and optionally substituted ( $C_3$ - $C_7$ )cycloalkyl in the definition of  $X^6$  is optionally independently substituted by 1 or 2 ( $C_1$ - $C_4$ )alkyl, hydroxyl, ( $C_1$ - $C_4$ )alkoxy, carboxyl, CONH<sub>2</sub>, -S(O)<sub>m</sub>( $C_1$ - $C_6$ )alkyl, carboxylate ( $C_1$ - $C_4$ )alkyl ester, or 1H-tetrazol-5-yl; or

when there are two  $X^6$  groups on one atom and both  $X^6$  are independently ( $C_1$ - $C_6$ )alkyl, the two ( $C_1$ - $C_6$ )alkyl groups may be optionally joined and, together with the atom to which the two  $X^6$  groups are attached, form a 4- to 9- membered ring optionally having oxygen, sulfur or  $NX^7$ ;

 $\chi^7$  is hydrogen or (C<sub>1</sub>-C<sub>6</sub>)alkyl optionally substituted with hydroxyl; and m for each occurrence is independently 0, 1 or 2;

with the proviso that:

20  $X^6$  and  $X^{12}$  cannot be hydrogen when it is attached to C(O) or SO<sub>2</sub> in the form C(O) $X^6$ , C(O) $X^{12}$ , SO<sub>2</sub> $X^6$  or SO<sub>2</sub> $X^{12}$ ; and when R<sup>6</sup> is a bond then L is N( $X^2$ ) and each r in the definition -(CH<sub>2</sub>)<sub>r</sub>-L-(CH<sub>2</sub>)<sub>r</sub>- is

when  $R^2$  is a bond then L is  $N(X^2)$  and each r in the definition  $-(Cn_2)_r$ -L- $(Cn_2)_r$ - is independently 2 or 3.

A preferred group of compounds, designated the "A Group", contains those compounds having the formula I as shown hereinabove wherein  $X^4$  is hydrogen;  $R^4$  is hydrogen or methyl;  $R^7$  is hydrogen or  $(C_1-C_3)$ alkyl;  $R^8$  is hydrogen or  $(C_1-C_3)$ alkyl optionally substituted with one or two hydroxyl groups;

$$Z^1$$
  $C$   $(CH_2)_a$   $(CH_2)_b$  where  $Z^1$  is a bond and a is 0 or 1;

X<sup>5</sup> and X<sup>5a</sup> are each independently hydrogen, trifluoromethyl, phenyl, optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl;

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where the optionally substituted  $(C_1-C_6)$ alkyl is optionally substituted with  $OX^2$ , imidazolyl, phenyl, indolyl, p-hydroxyphenyl,  $(C_5-C_7)$ cycloalkyl,  $-S(O)_m(C_1-C_6)$ alkyl,  $-N(X^2)(X^2)$  or  $-C(O)N(X^2)(X^2)$ :

or  $X^5$  and  $R^7$  are taken together to form a  $(C_1-C_5)$ alkylene bridge, and the other substituents not defined for the "A Group" compounds are as defined for formula (I) hereinabove.

A group of compounds, which is preferred among the "A Group" of compounds, designated the "B Group", contains those compounds of the "A Group", having the formula I as shown hereinabove, wherein b is 0;  $X^5$  and  $X^{5a}$  are each independently hydrogen,  $(C_1-C_3)$ alkyl or hydroxy $(C_1-C_3)$ alkyl;  $R^3$  is selected from the group consisting of 1-indolyl-CH<sub>2</sub>-, 2-indolyl-CH<sub>2</sub>-, 3-indolyl-CH<sub>2</sub>-, 1-naphthyl-CH<sub>2</sub>-, 2-naphthyl-CH<sub>2</sub>-, 1-benzimidazolyl-CH<sub>2</sub>-, 2-benzimidazolyl-CH<sub>2</sub>-, phenyl- $(C_1-C_4)$ alkyl-, 2-pyridyl- $(C_1-C_4)$ alkyl-, 3-pyridyl- $(C_1-C_4)$ alkyl-, 4-pyridyl- $(C_1-C_4)$ alkyl-, phenyl-CH<sub>2</sub>-S-CH<sub>2</sub>-, thienyl- $(C_1-C_4)$ alkyl-, phenyl- $(C_0-C_3)$ alkyl-O-CH<sub>2</sub>-, phenyl-CH<sub>2</sub>-O-phenyl-CH<sub>2</sub>-, and 3-benzothienyl-CH<sub>2</sub>-;

where the aryl portion(s) of the groups defined for R<sup>3</sup> are optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of methylenedioxy, F, Cl, CH<sub>3</sub>, OCH<sub>3</sub>, OCF<sub>2</sub>H and CF<sub>3</sub>.

A group of compounds, which is preferred among the "B Group" of compounds, designated the "C Group", contain those compounds of the "B Group", having the formula I as shown hereinabove, wherein R<sup>4</sup> is hydrogen; a is 0; n is 1 or 2; w is 0 or 1; X<sup>5</sup> and X<sup>5a</sup> are each independently, hydrogen, methyl or hydroxymethyl, provided that when X<sup>5</sup> is hydrogen then X<sup>5a</sup> is not hydrogen;

25 R<sup>7</sup> and R<sup>8</sup> are each hydrogen; and

 $R^3$  is phenyl-CH<sub>2</sub>-O-CH<sub>2</sub>-, phenyl-CH<sub>2</sub>-S-CH<sub>2</sub>-, 1-naphthyl-CH<sub>2</sub>-, 2-naphthyl-CH<sub>2</sub>-, phenyl-(CH<sub>2</sub>)<sub>3</sub>- or 3-indolyl-CH<sub>2</sub>-;

where the aryl portion of the groups defined for  $R^3$  is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of fluoro, chloro, methyl,  $OCH_3$ ,  $OCF_2H$ ,  $OCF_3$  and  $CF_3$ .

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A group of compounds, which is preferred among the "C Group" of compounds, designated the "D Group", contains those compounds of the "C Group", having the formula I as shown hereinabove, wherein  $R^1$  is  $-(CH_2)_t-A^1$ ,

- $(CH_2)_0$ - $(C_3$ - $C_7)$ cycloalkyl or  $(C_1$ - $C_{10})$ alkyl;

where A<sup>1</sup> in the definition of R<sup>1</sup> is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of fluoro, chloro, methyl, OCH<sub>3</sub>, OCF<sub>2</sub>H, OCF<sub>3</sub> and CF<sub>3</sub>;

the cycloalkyl and alkyl groups in the definition of  $R^1$  are optionally substituted with  $(C_1-C_4)$ alkyl, hydroxyl,  $(C_1-C_4)$ alkoxy, carboxyl, CONH<sub>2</sub>,

 $-S(O)_m(C_1-C_6)$ alkyl,  $-CO_2(C_1-C_4)$ alkyl ester, 1H-tetrazol-5-yl or 1 to 3 fluoro; Y is O; R<sup>2</sup> is hydrogen,  $-(C_0-C_3)$ alkyl- $-(C_3-C_8)$ cycloalkyl, phenyl or  $-(C_1-C_8)$ alkyl where the  $-(C_1-C_8)$ alkyl group is optionally substituted with hydroxyl,  $-CF_3$  or 1 to 3 halogen.

A group of compounds, which is preferred among the "D Group" of compounds, designated the "E Group", contains those compounds of the "D Group" wherein w is 0 and n is 1.

Another group of compounds, which is preferred among the "D Group" of compounds, designated the "F Group", are those compounds of the "D Group", having the formula I as shown hereinabove, wherein e is 0; n and w are each 1; R<sup>1</sup> is -(CH<sub>2</sub>)<sub>1</sub>-A<sup>1</sup>;

where A<sup>1</sup> in the definition of R<sup>1</sup> is phenyl, thienyl, thiazolyl, pyridyl or pyrimidyl which is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe, CF<sub>3</sub>, OCF<sub>3</sub> and OCF<sub>2</sub>H;

t is 0, 1 or 2;

and R<sup>3</sup> is phenyl-CH<sub>2</sub>-O-CH<sub>2</sub>-, phenyl-(CH<sub>2</sub>)<sub>3</sub>- or 3-indolyl-CH<sub>2</sub>-, where the aryl portion is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe, CF<sub>3</sub>, OCF<sub>3</sub> or OCF<sub>2</sub>H.

A group of compounds, which is preferred among the "F Group" of compounds, designated the "G Group", contains those compounds of the "F Group", having the formula I as shown hereinabove, wherein X<sup>5</sup> and X<sup>5a</sup> are each methyl; R<sup>1</sup> is -CH<sub>2</sub>-phenyl, -CH<sub>2</sub>-4-fluoro-phenyl, -CH<sub>2</sub>-pyridyl or -CH<sub>2</sub>-thiazolyl and R<sup>2</sup> is hydrogen, methyl, ethyl, t-butyl or -CH<sub>2</sub>CF<sub>3</sub>.

A group of compounds, which is preferred among the "G Group" of compounds, designated the "G¹ Group", contains those compounds of the "G Group", and have the formula

5 the racemic-diastereomeric mixtures and optical isomers of said compounds wherein

R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is methyl and R<sup>3</sup> is -(CH<sub>2</sub>)<sub>3</sub>-phenyl;

R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is methyl and R<sup>3</sup> is 3-indolyl-CH<sub>2</sub>-;

R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is ethyl and R<sup>3</sup> is 3-indolyl-CH<sub>2</sub>-;

R<sup>1</sup> is -CH<sub>2</sub>-4-fluoro-phenyl, R<sup>2</sup> is methyl and R<sup>3</sup> is 3-indolyl-CH<sub>2</sub>-;

10 R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is methyl and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-phenyl;

R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is ethyl and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-phenyl;

R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is -CH<sub>2</sub>-CF<sub>3</sub> and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-phenyl;

R<sup>1</sup> is -CH<sub>2</sub>-4-fluoro-phenyl, R<sup>2</sup> is methyl and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-phenyl;

R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is t-butyl and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-phenyl; or

15 R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is methyl and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-3,4-di-fluoro-phenyl.

The diastereomeric mixture of 2-amino-N-[2-(3a-(R,S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-(3,4-difluoro-benzyl-oxymethyl)-2-oxo-ethyl]-2-methyl-propionamide is preferred among the "G¹ Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

A group of compounds, which is preferred among the "G Group" of compounds, designated the "H Group", contains those compounds of the "G Group", having the formula I as shown hereinabove, wherein  $R^1$  is  $-CH_2$ -phenyl and  $R^3$  is phenyl- $(CH_2)_3$ -.

The diastereomeric mixture of 2-amino-N-[1-(3a-(R,S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridine-5-carbonyl)-4-phenyl-(R)-butyl]-isobutyramide is preferred among the "H Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

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A group of compounds, which is preferred among the "G Group" of compounds, designated the "I Group", contains those compounds of the "G Group" wherein  $R^1$  is -CH<sub>2</sub>-phenyl or -CH<sub>2</sub>-4-fluoro-phenyl and  $R^3$  is 3-indolyl-CH<sub>2</sub>-.

The diastereomeric mixture of 2-amino-N-[2-(3a-(R,S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo-[4,3-c]pyridin-5-yl)-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyl]-isobutyramide is preferred among the "I Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

The diastereomeric mixture of 2-amino-N-[2-(3a-(R,S)-benzyl-2-ethyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyl]-isobutyramide is also preferred among the "I Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

The diastereomeric mixture of 2-amino-N-[2-[3a-(R,S)-(4-fluoro-benzyl)-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyl]-isobutyramide is also preferred among the "I Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

A group of compounds which is preferred among the "G Group" of compounds, designated the "J Group", contains those compounds of the "G Group" wherein  $R^1$  is -CH<sub>2</sub>-phenyl or -CH<sub>2</sub>-4-fluoro-phenyl and  $R^3$  is phenyl-CH<sub>2</sub>-O-CH<sub>2</sub>-.

The diastereomeric mixture of 2-amino-N-[2-(3a-(R,S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide is preferred among the "J Group" of compounds, the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture, the 3a-(R) isomer is preferred over the 3a-(S) isomer, and the L-tartaric acid salt of the 3a-(R) isomer is a preferred salt.

The diastereomeric mixture of 2-amino-N-[2-(3a-(R,S)-benzyl-2-ethyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide is also preferred among the "J Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

The diastereomeric mixture of 2-amino-N-{2-[3a-(R,S)-benzyl-3-oxo-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-1-(R)-benzyloxymethyl-2-oxo-ethyl}-isobutyramide is also preferred among the "J Group"

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of compounds, the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture and the 3a-(R) isomer is preferred over the 3a-(S) isomer.

The diastereomeric mixture of 2-amino-N-{1-(R)-benzyloxymethyl-2-[3a-(R,S)-(4-fluoro-benzyl)-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-2-oxo-ethyl}-isobutyramide is also preferred among the "J Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

The diastereomeric mixture of 2-amino-N-[2-(3a-(R,S)-benzyl-2-tert-butyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide is also preferred among the "J Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

A group of compounds which is preferred among the "D Group" of compounds, designated the "K Group", contains those compounds of the "D Group" wherein e is 1; n is 1; w is 1; R<sup>1</sup> is -(CH<sub>2</sub>)<sub>1</sub>-A<sup>1</sup>;

where  $A^1$  in the definition of  $R^1$  is phenyl, thienyl, thiazolyl, pyridyl or pyrimidyl which is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe,  $CF_3$ ,  $OCF_3$  and  $OCF_2H$ ;

t is 0, 1 or 2;

and  $R^3$  is phenyl- $CH_2$ -O- $CH_2$ -, phenyl- $(CH_2)_3$ - or 3-indolyl- $CH_2$ -, where the aryl portion is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe,  $CF_3$ ,  $OCF_3$  or  $OCF_2H$ .

A group of compounds which is preferred among the "K Group" of compounds, designated the "L Group", are those compounds of the "K Group" wherein  $X^5$  and  $X^{5a}$  are each methyl;  $R^1$  is -CH<sub>2</sub>-phenyl, -CH<sub>2</sub>-4-fluoro-phenyl, -CH<sub>2</sub>-pyridyl or -CH<sub>2</sub>-thiazolyl and  $R^2$  is hydrogen, methyl, ethyl, t-butyl or -CH<sub>2</sub>CF<sub>3</sub>.

A group of compounds which is preferred among the "L Group", designated the "L¹ Group", are those compounds of the "L Group" wherein R¹ is -CH₂-phenyl; R² is hydrogen or methyl and R³ is -CH₂-O-CH₂-phenyl.

The diastereomeric mixture of 2-amino-N-[2-(3a-(R,S)-benzyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide is preferred among the "J Group", the separated 3a-(R) and 3a-

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(S) isomers are preferred of the diastereomeric mixture and the 3a-(R) isomer is preferred over the 3a-(S) isomer.

Another group of compounds, which is preferred among the "A Group" of compounds, designated the "M Group", contains those compounds of the "A Group", having the formula I as shown hereinabove, wherein b is 0;  $X^5$  and  $X^{5a}$  are each independently hydrogen, (C<sub>1</sub>-C<sub>3</sub>)alkyl or hydroxy(C<sub>1</sub>-C<sub>3</sub>)alkyl;  $R^3$  is selected from the group consisting of 1-indolyl-CH<sub>2</sub>-, 2-indolyl-CH<sub>2</sub>-, 3-indolyl-CH<sub>2</sub>-, 2-indolyl-CH<sub>2</sub>-, 3-indolyl-CH<sub>2</sub>-, 3-indolyl-CH<sub>2</sub>-,

R³ is selected from the group consisting of 1-indolyl-CH<sub>2</sub>-, 2-indolyl-CH<sub>2</sub>-, 3-indolyl-CH<sub>2</sub>-, 1-naphthyl-CH<sub>2</sub>-, 2-naphthyl-CH<sub>2</sub>-, 1-benzimidazolyl-CH<sub>2</sub>-, 2-benzimidazolyl-CH<sub>2</sub>-, phenyl-(C<sub>1</sub>-C<sub>4</sub>)alkyl-, 2-pyridyl-(C<sub>1</sub>-C<sub>4</sub>)alkyl-, 3-pyridyl-(C<sub>1</sub>-C<sub>4</sub>)alkyl-, 4-pyridyl-(C<sub>1</sub>-C<sub>4</sub>)alkyl-, phenyl-CH<sub>2</sub>-S-CH<sub>2</sub>-, thienyl-(C<sub>1</sub>-C<sub>4</sub>)alkyl-, phenyl-(C<sub>0</sub>-C<sub>3</sub>)alkyl-O-CH<sub>2</sub>-, phenyl-CH<sub>2</sub>-O-phenyl-CH<sub>2</sub>-, 3-benzothienyl-CH<sub>2</sub>-, thienyl-CH<sub>2</sub>-O-CH<sub>2</sub>-, thiazolyl-CH<sub>2</sub>-O-CH<sub>2</sub>-, pyridyl-CH<sub>2</sub>-O-CH<sub>2</sub>-, pyrimidyl-CH<sub>2</sub>-O-CH<sub>2</sub>- and phenyl-O-CH<sub>2</sub>-CH<sub>2</sub>;

where the aryl portion(s) of the groups defined for R<sup>3</sup> are optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of methylenedioxy, F, Cl, CH<sub>3</sub>, OCH<sub>3</sub>, OCF<sub>3</sub>, OCF<sub>2</sub>H and CF<sub>3</sub>.

A group of compounds, which is preferred among the "M Group" of compounds, designated the "M¹ Group", contains those compounds of the "M Group", having the formula I as shown hereinabove, wherein R⁴ is hydrogen; a is 0; n is 1; w is 1; e is 0; X⁵ and X⁵ are each independently, hydrogen, methyl or hydroxymethyl, provided that when X⁵ is hydrogen then X⁵ is not hydrogen; R² and R⁵ are each hydrogen; Y is oxygen; R² is hydrogen, methyl, ethyl, propyl, i-propyl, t-butyl, -CH₂CF₃, CF₃ or -CH₂-cyclopropyl; R¹ is CH₂-A¹; where A¹ in the definition of R¹ is phenyl, thienyl, thiazolyl, pyridyl or pyrimidyl which is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe, CF₃, OCF₃ and OCF₂H; and R³ is phenyl-CH₂-O-CH₂-, phenyl-(CH₂)₃-, 3-indolyl-CH₂-O-CH₂-, thienyl-CH₂-O-CH₂-, thiazolyl-CH₂-O-CH₂-, pyridyl-CH₂-O-CH₂-, pyrimidyl-CH₂-O-CH₂- or phenyl-O-CH₂-CH₂, where the aryl portion is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe, CF₃, OCF₃ and OCF₂H.

A group of compounds, which is preferred among the "M<sup>1</sup> Group" of compounds, designated the "N Group", contains those compounds of th "M<sup>1</sup>

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Group", having the formula I as shown hereinabove, wherein  $X^5$  and  $X^{5a}$  are each methyl;  $R^2$  is methyl, ethyl, or  $-CH_2CF_3$ ;  $A^1$  is phenyl optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe,  $CF_3$ ,  $OCF_3$  and  $OCF_2H$ ;  $R^3$  is phenyl- $CH_2$ -O- $CH_2$ -, phenyl- $CH_2$ -O- $CH_2$ - where the aryl portion is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe,  $CF_3$ ,  $OCF_3$  and  $OCF_2H$ .

Another group of compounds, which is preferred among the "M¹ Group" of compounds, designated the "O Group", contains those compounds of the "M¹ Group", having the formula I as shown hereinabove, wherein X⁵ and X⁵a are each methyl; R² is methyl, ethyl, or CH₂CF₃; A¹ is 2-pyridyl or 3-pyridyl optionally substituted with one to two substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe, CF₃, OCF₃ and OCF₂H; R³ is phenyl-CH₂-O-CH₂-, phenyl-(CH₂)₃- or thienyl-CH₂-O-CH₂- where the aryl portion is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe, CF₃, OCF₃ and OCF₂H.

Another group of compounds, which is preferred among the "M¹ Group" of compounds, designated the "P Group", contains those compounds of the "M¹ Group", having the formula I as shown hereinabove, wherein X⁵ and X⁵a are each methyl; R² is methyl, ethyl, or CH₂CF₃; A¹ is phenyl optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe, CF₃, OCF₃ and OCF₂H; R³ is 2-pyridyl-CH₂-O-CH₂-, or 3-pyridyl-CH₂-O-CH₂- where the aryl portion is optionally substituted with one to two substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe, CF₃, OCF₃ and OCF₂H.

A group of compounds, which is preferred among the "O Group" of compounds, designated the "Q Group", contains those compounds of the "O Group", having the formula

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the racemic-diastereomeric mixtures and optical isomers of said compounds wherein R<sup>2</sup> is methyl; A<sup>1</sup> is 2-pyridyl; and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-phenyl;

R<sup>2</sup> is CH<sub>2</sub>CF<sub>3</sub>; A<sup>1</sup> is 2-pyridyl; and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-3-chloro-phenyl;

R<sup>2</sup> is CH<sub>2</sub>CF<sub>3</sub>; A<sup>1</sup> is 2-pyridyl; and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-4-chloro-phenyl;

R<sup>2</sup> is CH<sub>2</sub>CF<sub>3</sub>; A<sup>1</sup> is 2-pyridyl; and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-2,4-di-chloro-phenyl;

 $R^2$  is  $CH_2CF_3$ ;  $A^1$  is 2-pyridyl; and  $R^3$  is  $-CH_2-O-CH_2-3$ -chloro-thiophene; or

R<sup>2</sup> is CH<sub>2</sub>CF<sub>3</sub>; A<sup>1</sup> is 2-pyridyl; and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-2,4-di-fluoro-phenyl.

The diastereomeric mixture of 2-amino-N-[1-(R)-benzyloxymethyl-2-(2-methyl-3-oxo-3a-(R,S)-pyridin-2-ylmethyl-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-2-oxo-ethyl]-2-methyl-propionamide is preferred among the "Q Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

The diastereomeric mixture of 2-amino-N-(1-(R)-(3-chloro-benzyloxy-methyl)-2-oxo-2-[3-oxo-3a-(R,S)-pyridin-2-ylmethyl-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-

hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-ethyl]-2-methyl-propionamide is preferred among the "Q Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

The diastereomeric mixture of 2-amino-N-{1-(R)-(4-chloro-benzyloxy-methyl)-2-oxo-2-[3-oxo-3a-(R,S)-pyridin-2-ylmethyl-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-ethyl}-2-methyl-propionamide is preferred among the "Q Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

The diastereomeric mixture of 2-amino-N-{1-(R)-(2,4-dichlorobenzyloxymethyl)-2-oxo-2-[3-oxo-3a-(R,S)-pyridin-2-ylmethyl-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-ethyl}-2-methyl-propionamide is preferred among the "Q Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

The diastereomeric mixture of 2-amino-N-{1-(R)-(4-chloro-thiophen-2-ylmethoxymethyl)-2-oxo-2-[3-oxo-3a-(R,S)-pyridin-2-ylmethyl-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,5,7-hexahydro-pyrazolo[3,4-c]pyridin-6-yl]-ethyl}-2-methyl-propionamide is preferred among the "Q Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diast r omeric mixture.

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The diastereomeric mixture of 2-amino-N-{1-(R)-(2,4-difluoro-benzyloxymethyl)-2-oxo-2-[3-oxo-3a-(R,S)-pyridin-2-ylmethyl-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-ethyl}-2-methyl-propionamide is preferred among the "Q Group" of compounds and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

A group of compounds which contains intermediates useful in synthesizing the compounds of formula (I) are of the formula

$$\begin{array}{c|c}
O & (CH_2)_e & (CH_2)_n \\
N & N & (CH_2)_w \\
R^2 & N & (II)
\end{array}$$

the racemic-diastereomeric mixtures and optical isomers of said compounds and the 10 pharmaceutically-acceptable salts thereof, wherein e is 0 or 1; n and w are each independently 0, 1 or 2, provided that w and n cannot both be 0 at the same time;  $R^1$  is hydrogen, -CN, -(CH<sub>2</sub>)<sub>q</sub>N(X<sup>6</sup>)C(O)X<sup>6</sup>, -(CH<sub>2</sub>)<sub>q</sub>N(X<sup>6</sup>)C(O)(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>,  $-(CH_2)_0N(X^6)SO_2(CH_2)_t-A^1$ ,  $-(CH_2)_0N(X^6)SO_2X^6$ ,  $-(CH_2)_0N(X^6)C(O)N(X^6)(CH_3)_t-A^1$ .  $-(CH_2)_{\alpha}N(X^6)C(O)N(X^6)(X^6), -(CH_2)_{\alpha}C(O)N(X^6)(X^6), -(CH_2)_{\alpha}C(O)N(X^6)(CH_2)_{t}-A^1,$ 15  $-(CH_2)_{\sigma}C(O)OX^6$ ,  $-(CH_2)_{\sigma}C(O)O(CH_2)_{I}-A^1$ ,  $-(CH_2)_{\sigma}OX^6$ ,  $-(CH_2)_{\sigma}OC(O)X^6$ .  $-(CH_2)_qOC(O)(CH_2)_t-A^1, -(CH_2)_qOC(O)N(X^6)(CH_2)_t-A^1, -(CH_2)_qOC(O)N(X^6)(X^6), -(CH_2)_qOC(O)N(X^6), -(CH_2)_qOC(O)N(X^6)$  $-(CH_2)_0C(O)X^6$ ,  $-(CH_2)_0C(O)(CH_2)_1-A^1$ ,  $-(CH_2)_0N(X^6)C(O)OX^6$ .  $-(CH_2)_0N(X^6)SO_2N(X^6)(X^6)$ ,  $-(CH_2)_0S(O)_mX^6$ ,  $-(CH_2)_0S(O)_m(CH_2)_1-A^1$  $-(C_1-C_{10})$ alkyl,  $-(CH_2)_t-A^1$ ,  $-(CH_2)_a-(C_3-C_7)$ cycloalkyl,  $-(CH_2)_a-Y^1-(C_1-C_6)$ alkyl, 20  $-(CH_2)_0 - Y^1 - (CH_2)_t - A^1$  or  $-(CH_2)_0 - Y^1 - (CH_2)_t - (C_3 - C_7)$  cycloalkyl: where the alkyl and cycloalkyl groups in the definition of R1 are optionally substituted with (C<sub>1</sub>-C<sub>4</sub>)alkyl, hydroxyl, (C<sub>1</sub>-C<sub>4</sub>)alkoxy, carboxyl, CONH<sub>2</sub>.

 $-S(O)_m(C_1-C_6)$  alkyl,  $-CO_2(C_1-C_4)$  alkyl, 1H-tetrazol-5-yl or 1 to 3 fluoro; Y<sup>1</sup> is O, S(O)<sub>m</sub>, -C(O)NX<sup>6</sup>, -CH=CH-, -C=C-, -N(X<sup>6</sup>)C(O)-, -C(O)NX<sup>6</sup>-, -C(O)O-. -OC(O)N(X<sup>6</sup>)- or -OC(O)-; q is 0, 1, 2, 3 or 4; t is 0, 1, 2 or 3; said (CH<sub>2</sub>)<sub>a</sub> group and (CH<sub>2</sub>)<sub>t</sub> group may each be optionally substituted with 1 to 3 fluoro, 1 or 2 (C<sub>1</sub>-C<sub>4</sub>)alkyl, hydroxyl, (C<sub>1</sub>-C<sub>4</sub>)alkoxy, carboxyl, -CONH<sub>2</sub>,

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 $-S(O)_m(C_1-C_6)$ alkyl,  $-CO_2(C_1-C_4)$ alkyl ester, or 1H-tetrazol-5-yl;

 $R^2$  is hydrogen,  $(C_1-C_8)$ alkyl,  $-(C_0-C_3)$ alkyl- $(C_3-C_8)$ cycloalkyl,  $-(C_1-C_4)$ alkyl- $A^1$  or  $A^1$ ; where the alkyl groups and the cycloalkyl groups in the definition of  $R^2$  are optionally substituted by hydroxyl,  $-C(O)OX^6$ ,  $-C(O)N(X^6)(X^6)$ ,  $-N(X^6)(X^6)$ ,

 $-S(O)_m(C_1-C_6)$ alkyl,  $-C(O)A^1$ ,  $-C(O)(X^6)$ , CF<sub>3</sub>, CN or 1 to 3 halogen;

A¹ for each occurrence is independently (C<sub>5</sub>-C<sub>7</sub>)cycloalkenyl, phenyl or a partially saturated, fully saturated or fully unsaturated 4- to 8-membered ring optionally having 1 to 4 heteroatoms independently selected from the group consisting of oxygen, sulfur and nitrogen, or a bicyclic ring system consisting of a partially saturated, fully unsaturated or fully saturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen, fused to a partially saturated, fully saturated or fully unsaturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen;

A<sup>1</sup> for each occurrence is independently optionally substituted, in one or optionally both rings if A<sup>1</sup> is a bicyclic ring system, with up to three substituents, each substituent independently selected from the group consisting of F, Cl, Br, I, OCF<sub>3</sub>, OCF<sub>2</sub>H, CF<sub>3</sub>, CH<sub>3</sub>, OCH<sub>3</sub>, -OX<sup>6</sup>,

-C(O)N( $X^6$ )( $X^6$ ), -C(O)OX<sup>6</sup>, oxo, (C<sub>1</sub>-C<sub>6</sub>)alkyl, nitro, cyano, benzyl,

 $-S(O)_m(C_1-C_6)alkyl, \quad 1H-tetrazol-5-yl, \quad phenyl, \quad phenoxy, \quad phenylalkyloxy, \\ halophenyl, \quad methylenedioxy, \quad -N(X^6)(X^6), \quad -N(X^6)C(O)(X^6), \quad -SO_2N(X^6)(X^6), \\ -N(X^6)SO_2-phenyl, \quad -N(X^6)SO_2X^6, \quad -CONX^{11}X^{12}, \quad -SO_2NX^{11}X^{12}, \quad -NX^6SO_2X^{12}, \\ -NX^6CONX^{11}X^{12}, \quad -NX^6SO_2NX^{11}X^{12}, \quad -NX^6C(O)X^{12}, \quad imidazolyl, \quad thiazolyl \quad and \\ -NX^6CONX^{11}X^{12}, \quad -NX^6SO_2NX^{11}X^{12}, \quad -NX^6C(O)X^{12}, \quad imidazolyl, \quad thiazolyl \quad and \\ -NX^6CONX^{11}X^{12}, \quad -NX^6SO_2NX^{11}X^{12}, \quad -NX^6C(O)X^{12}, \quad imidazolyl, \quad thiazolyl \quad and \\ -NX^6CONX^{11}X^{12}, \quad -NX^6SO_2NX^{11}X^{12}, \quad -NX^6C(O)X^{12}, \quad imidazolyl, \quad thiazolyl \quad and \\ -NX^6CONX^{11}X^{12}, \quad -NX^6SO_2NX^{11}X^{12}, \quad -NX^6C(O)X^{12}, \quad imidazolyl, \quad thiazolyl \quad and \\ -NX^6CONX^{11}X^{12}, \quad -NX^6SO_2NX^{11}X^{12}, \quad -NX^6C(O)X^{12}, \quad imidazolyl, \quad thiazolyl \quad and \\ -NX^6CONX^{11}X^{12}, \quad -NX^6SO_2NX^{11}X^{12}, \quad -NX^6C(O)X^{12}, \quad -NX^6C(O)X^{1$ 

tetrazolyl, provided that if  $A^1$  is optionally substituted with methylenedioxy then it can only be substituted by one methylenedioxy;

where  $X^{11}$  is hydrogen or optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl;

the optionally substituted ( $C_1$ - $C_6$ )alkyl defined for  $X^{11}$  is optionally independently substituted with phenyl, phenoxy, ( $C_1$ - $C_6$ )alkoxycarbonyl, -S(O)<sub>m</sub>( $C_1$ - $C_6$ )alkyl, 1 to 5 halogens, 1 to 3 hydroxy, 1 to 3 ( $C_1$ - $C_{10}$ )alkanoyloxy or 1 to 3 ( $C_1$ - $C_6$ )alkoxy;

 $X^{12}$  is hydrogen,  $(C_1-C_6)$ alkyl, phenyl, thiazolyl, imidazolyl, furyl or thienyl, provided that when  $X^{12}$  is not hydrogen,  $X^{12}$  is optionally

substituted with one to three substituents independently selected from the group consisting of CI, F, CH<sub>3</sub>, OCH<sub>3</sub>, OCF<sub>3</sub> and CF<sub>3</sub>; or  $X^{11}$  and  $X^{12}$  are taken together to form -(CH<sub>2</sub>)<sub>r</sub>-L<sup>1</sup>-(CH<sub>2</sub>)<sub>r</sub>-; L<sup>1</sup> is C( $X^{2}$ )( $X^{2}$ ), O, S(O)<sub>m</sub> or N( $X^{2}$ );

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r for each occurrence is independently 1, 2 or 3;

 $X^2$  for each occurrence is independently hydrogen, optionally substituted ( $C_1$ - $C_6$ )alkyl, or optionally substituted ( $C_3$ - $C_7$ )cycloalkyl, where the optionally substituted ( $C_1$ - $C_6$ )alkyl and optionally substituted ( $C_3$ - $C_7$ )cycloalkyl in the definition of  $X^2$  are optionally independently substituted with  $-S(O)_m(C_1$ - $C_6$ )alkyl,  $-C(O)OX^3$ , 1 to 5 halogens or 1 to 3  $OX^3$ ;

X<sup>3</sup> for each occurrence is independently hydrogen or (C<sub>1</sub>-C<sub>6</sub>)alkyl;

 $X^6$  for each occurrence is independently hydrogen, optionally substituted ( $C_1$ - $C_6$ )alkyl, ( $C_2$ - $C_6$ )halogenated alkyl, optionally substituted ( $C_3$ - $C_7$ )cycloalkyl, ( $C_3$ - $C_7$ )halogenatedcycloalkyl, where optionally substituted ( $C_1$ - $C_6$ )alkyl and optionally substituted ( $C_3$ - $C_7$ )cycloalkyl in the definition of  $X^6$  is optionally independently substituted by, hydroxyl, ( $C_1$ - $C_4$ )alkoxy, carboxyl, CONH<sub>2</sub>, -S(O)<sub>m</sub>( $C_1$ - $C_6$ )alkyl,

-CO $_2$ (C $_1$ -C $_4$ )alkyl, 1H-tetrazol-5-yl or 1 or 2 (C $_1$ -C $_4$ )alkyl; or

where there are two  $X^6$  groups on one atom and both  $X^6$  are  $(C_1-C_6)$ alkyl, the two  $(C_1-C_6)$ alkyl groups may be optionally joined and, together with the atom to which the two  $X^6$  groups are attached, form a 4- to 9- membered ring optionally having oxygen, sulfur or  $NX^7$ ;

 $X^7$  is hydrogen or (C<sub>1</sub>-C<sub>6</sub>)alkyl optionally substituted with hydroxyl; and m for each occurrence is independently 0, 1 or 2; with the proviso that:

25 X<sup>6</sup> and X<sup>12</sup> cannot be hydrogen when it is attached to C(O) or SO<sub>2</sub> in the form C(O)X<sup>6</sup>, C(O)X<sup>12</sup>, SO<sub>2</sub>X<sup>6</sup> or SO<sub>2</sub>X<sup>12</sup>; and when R<sup>2</sup> is hydrogen then R<sup>1</sup> is not -CH=CH-phenyl.

A group of intermediate compounds preferred among the foregoing group of formula (II), designated "Group AA", contains those compounds wherein w is 0 or 1; n is 1;  $R^1$  is hydrogen,  $-(CH_2)_q-(C_3-C_7)$ cycloalkyl,  $-(CH_2)_t-A^1$  or  $(C_1-C_{10})$ alkyl where the  $(C_1-C_{10})$ alkyl and  $(C_3-C_7)$ cycloalkyl groups are optionally substituted with 1 to 3 fluoro and  $A^1$  in the definition of  $R^1$  is optionally substituted with 1 to 3 substituents independently selected from the group consisting of F, CI, Me, methoxy,  $CF_3$ ,  $CCF_3$ 

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and  $OCF_2H$ ;  $R^2$  is hydrogen,  $(C_1-C_8)$ alkyl,  $(C_0-C_3)$ alkyl- $(C_3-C_7)$ cycloalkyl, phenyl, or  $(C_1-C_3)$ alkyl-phenyl where the alkyl and phenyl groups are optionally substituted with 1 to 3 substituents independently selected from the group consisting of F,  $CF_3$ , OH and methoxy.

A group of compounds preferred among the "AA Group" compounds, designated "BB Group", contains those compounds of "AA Group" wherein w is 1; e is 0;  $R^1$  is - $CH_2$ -pyridyl, - $CH_2$ -thiazolyl, or - $CH_2$ -phenyl optionally substituted with 1 to 3 substituents independently selected from the group consisting of fluoro and chloro; and  $R^2$  is hydrogen, ( $C_1$ - $C_4$ )alkyl or phenyl where the ( $C_1$ - $C_4$ )alkyl or phenyl groups in the definition of  $R^2$  is optionally substituted with 1 to 3 substituents independently selected from the group consisting of fluoro, hydroxy or methoxy.

Compounds which are preferred among the "BB Group" compounds is the diastereomeric mixture of a compound wherein R<sup>1</sup> is -CH<sub>2</sub>-phenyl and R<sup>2</sup> is methyl or hydrogen; and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

Another group of intermediate compounds which are useful in the synthesis of the compounds of formula (I) have the formula

the racemic-diastereomeric mixtures and optical isomers of said compounds wherein Z<sup>100</sup> is methyl, BOC, CBZ, CF<sub>3</sub>C(O)-, FMOC, TROC, trityl, tosyl, CH<sub>3</sub>C(O)- or optionally substituted benzyl which optionally substituted with methoxy, dimethoxy or nitro; e is 0 or 1; n and w are each independently 0, 1 or 2, provided that w and n cannot both be 0 at the same time;

 $\begin{array}{lll} 25 & \mathsf{R}^1 & \mathsf{is\ hydrogen,\ -CN,\ -(CH_2)_qN(X^6)C(O)X^6,\ -(CH_2)_qN(X^6)C(O)(CH_2)_t-A^1,} \\ & -(CH_2)_q\mathsf{N}(X^6)\mathsf{SO}_2(\mathsf{CH}_2)_t-A^1,\ -(CH_2)_q\mathsf{N}(X^6)\mathsf{SO}_2X^6,\ -(CH_2)_q\mathsf{N}(X^6)C(O)\mathsf{N}(X^6)(\mathsf{CH}_2)_t-A^1,} \\ & -(CH_2)_q\mathsf{N}(X^6)C(O)\mathsf{N}(X^6)(X^6),\ -(CH_2)_qC(O)\mathsf{N}(X^6)(X^6),\ -(CH_2)_qC(O)\mathsf{N}(X^6)(\mathsf{CH}_2)_t-A^1,} \\ & -(CH_2)_qC(O)\mathsf{O}X^6,\ -(CH_2)_qC(O)\mathsf{O}(\mathsf{CH}_2)_t-A^1,\ -(CH_2)_q\mathsf{O}X^6,\ -(CH_2)_q\mathsf{O}(\mathsf{O})X^6,} \end{array}$ 

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 $-(CH_2)_q OC(O)(CH_2)_t - A^1, -(CH_2)_q OC(O)N(X^6)(CH_2)_t - A^1, -(CH_2)_q OC(O)N(X^6)(X^6), \\ -(CH_2)_q C(O)X^6, -(CH_2)_q C(O)(CH_2)_t - A^1, -(CH_2)_q N(X^6)C(O)OX^6, \\ -(CH_2)_q N(X^6)SO_2N(X^6)(X^6), -(CH_2)_q S(O)_m X^6, -(CH_2)_q S(O)_m (CH_2)_t - A^1, \\ -(C_1 - C_{10})alkyl, -(CH_2)_t - A^1, -(CH_2)_q - (C_3 - C_7)cycloalkyl, -(CH_2)_q - Y^1 - (C_1 - C_6)alkyl, \\ -(CH_2)_q - Y^1 - (CH_2)_t - A^1 \text{ or } -(CH_2)_q - Y^1 - (CH_2)_t - (C_3 - C_7)cycloalkyl;$ 

where the alkyl and cycloalkyl groups in the definition of  $R^1$  are optionally substituted with  $(C_1-C_4)$ alkyl, hydroxyl,  $(C_1-C_4)$ alkoxy, carboxyl, CONH<sub>2</sub>,  $-S(O)_m(C_1-C_6)$ alkyl,  $-CO_2(C_1-C_4)$ alkyl, 1H-tetrazol-5-yl or 1 to 3 fluoro;

 $Y^1$  is O,  $S(O)_m$ ,  $-C(O)NX^6$ , -CH=CH-,  $-C\equiv C-$ ,  $-N(X^6)C(O)$ ,  $-C(O)NX^6$ ,

10  $-C(O)O, -OC(O)N(X^6) \text{ or } -OC(O);$ 

q is 0, 1, 2, 3 or 4;

t is 0, 1, 2 or 3;

said  $(CH_2)_q$  group and  $(CH_2)_t$  group may each be optionally substituted with hydroxyl,  $(C_1-C_4)$ alkoxy, carboxyl,  $-CONH_2$ ,  $-S(O)_m(C_1-C_6)$ alkyl,

-CO<sub>2</sub>(C<sub>1</sub>-C<sub>4</sub>)alkyl, 1H-tetrazol-5-yl, 1 to 3 fluoro or 1 or 2 (C<sub>1</sub>-C<sub>4</sub>)alkyl;

R<sup>2</sup> is hydrogen, (C<sub>1</sub>-C<sub>8</sub>)alkyl, -(C<sub>0</sub>-C<sub>3</sub>)alkyl-(C<sub>3</sub>-C<sub>8</sub>)cycloalkyl, -(C<sub>1</sub>-C<sub>4</sub>)alkyl-A<sup>1</sup> or A<sup>1</sup>;

where the alkyl groups and the cycloalkyl groups in the definition of R<sup>2</sup> are optionally substituted with hydroxyl, -C(O)OX<sup>6</sup>, -C(O)N(X<sup>6</sup>)(X<sup>6</sup>), -N(X<sup>6</sup>)(X<sup>6</sup>),

 $-S(O)_m(C_1-C_6)$  alkyl,  $-C(O)(A^1, -C(O)(X^6), CF_3, CN or 1 to 3 halogen;$ 

A¹ for each occurrence is independently (C<sub>5</sub>-C<sub>7</sub>)cycloalkenyl, phenyl or a partially saturated, fully saturated or fully unsaturated 4- to 8-membered ring optionally having 1 to 4 heteroatoms independently selected from the group consisting of oxygen, sulfur and nitrogen, or a bicyclic ring system consisting of a partially saturated, fully unsaturated or fully saturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen, fused to a partially saturated, fully saturated or fully unsaturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen;

A<sup>1</sup> for each occurrence is independently optionally substituted, in one or optionally both rings if A<sup>1</sup> is a bicyclic ring system, with up to three substituents, each substituent independently selected from the group consisting of F, Cl, Br, I, OCF<sub>3</sub>, OCF<sub>2</sub>H<sub>1</sub>, CF<sub>3</sub>, CH<sub>3</sub>, OCH<sub>3</sub>,  $-OX^6$ ,  $-C(O)N(X^6)(X^6)$ ,  $-C(O)OX^6$ , oxo,  $(C_1-C_6)$ alkyl, nitro, cyano, benzyl,

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-S(O)<sub>m</sub>(C<sub>1</sub>-C<sub>6</sub>)alkyl, 1H-tetrazol-5-yl, phenyl, phenoxy, phenylalkyloxy, halophenyl, methylenedioxy, -N(X<sup>6</sup>)(X<sup>6</sup>), -N(X<sup>6</sup>)C(O)(X<sup>6</sup>), -SO<sub>2</sub>N(X<sup>6</sup>)(X<sup>6</sup>), -N(X<sup>6</sup>)SO<sub>2</sub>-phenyl, -N(X<sup>6</sup>)SO<sub>2</sub>X<sup>6</sup>, -CONX<sup>11</sup>X<sup>12</sup>, -SO<sub>2</sub>NX<sup>11</sup>X<sup>12</sup>, -NX<sup>6</sup>SO<sub>2</sub>X<sup>12</sup>, -NX<sup>6</sup>CONX<sup>11</sup>X<sup>12</sup>, -NX<sup>6</sup>SO<sub>2</sub>NX<sup>11</sup>X<sup>12</sup>, -NX<sup>6</sup>C(O)X<sup>12</sup>, imidazolyl, thiazolyl and tetrazolyl, provided that if A<sup>1</sup> is optionally substituted with methylenedioxy then it can only be substituted with one methylenedioxy;

where X<sup>11</sup> is hydrogen or optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl;

the optionally substituted  $(C_1-C_6)$ alkyl defined for  $X^{11}$  is optionally independently substituted with phenyl, phenoxy,  $(C_1-C_6)$ alkoxycarbonyl,  $-S(O)_m(C_1-C_6)$ alkyl, 1 to 5 halogens, 1 to 3 hydroxy, 1 to 3  $(C_1-C_6)$ alkoxy;

 $X^{12}$  is hydrogen, (C<sub>1</sub>-C<sub>6</sub>)alkyl, phenyl, thiazolyl, imidazolyl, furyl or thienyl, provided that when  $X^{12}$  is not hydrogen,  $X^{12}$  is optionally substituted with one to three substituents independently selected from the group consisting of Cl, F, CH<sub>3</sub>, OCH<sub>3</sub>, OCF<sub>3</sub> and CF<sub>3</sub>;

or  $X^{11}$  and  $X^{12}$  are taken together to form -(CH<sub>2</sub>)<sub>r</sub>-L<sup>1</sup>-(CH<sub>2</sub>)<sub>r</sub>-;

 $L^1$  is  $C(X^2)(X^2)$ , O,  $S(O)_m$  or  $N(X^2)$ ;

r for each occurrence is independently 1, 2 or 3;

 $X^2$  for each occurrence is independently hydrogen, optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl, or optionally substituted (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl, where the optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl and optionally substituted (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl in the definition of  $X^2$  are optionally independently substituted with  $-S(O)_m(C_1-C_6)$ alkyl,  $-C(O)OX^3$ , 1 to 5 halogens or 1 to 3  $OX^3$ ;

X<sup>3</sup> for each occurrence is independently hydrogen or (C<sub>1</sub>-C<sub>6</sub>)alkyl;

 $X^6$  for each occurrence is independently hydrogen, optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>2</sub>-C<sub>6</sub>)halogenated alkyl, optionally substituted (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl, (C<sub>3</sub>-C<sub>7</sub>)-halogenated cycloalkyl, where optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl and optionally substituted (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl in the definition of  $X^6$  is optionally independently substituted with hydroxyl, (C<sub>1</sub>-C<sub>4</sub>)alkoxy, carboxyl, CONH<sub>2</sub>, -S(O)<sub>m</sub>(C<sub>1</sub>-C<sub>6</sub>)alkyl,

30 -CO<sub>2</sub>(C<sub>1</sub>-C<sub>4</sub>)alkyl, 1H-tetrazol-5-yl or 1 or 2 (C<sub>1</sub>-C<sub>4</sub>)alkyl; or where there are two X<sup>6</sup> groups on one atom and both X<sup>6</sup> are (C<sub>1</sub>-C<sub>6</sub>)alkyl groups may be optionally joined and, together with the atom to which th

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two X<sup>6</sup> groups are attached, form a 4- to 9- membered ring optionally having oxygen, sulfur or NX<sup>7</sup>;

 $X^7$  is hydrogen or (C<sub>1</sub>-C<sub>6</sub>)alkyl optionally substituted with hydroxyl; and m for each occurrence is independently 0, 1 or 2;

5 with the proviso that:

 $X^6$  and  $X^{12}$  cannot be hydrogen when it is attached to C(O) or SO<sub>2</sub> in the form C(O) $X^6$ , C(O) $X^{12}$ , SO<sub>2</sub> $X^6$  or SO<sub>2</sub> $X^{12}$ ;

when R<sup>2</sup> is hydrogen then R<sup>1</sup> is not -CH=CH-phenyl;

when R2 is H and R1 is -CH2-CH=CH-Ph, then Z100 is not BOC:

10 when R<sup>2</sup> is H and R<sup>1</sup> is then Z<sup>100</sup> is not BOC:

when  $R^2$  is H and  $R^1$  is  $-CH_2$ -C( $CH_3$ )= $CH_2$ , then  $Z^{100}$  is not BOC; and when  $R^2$  is phenyl and  $R^1$  is  $-CH_3$ , then  $Z^{100}$  is not  $CH_3C(O)$ -.

A group of compounds preferred among the foregoing group of compounds of formula (III), designated "CC Group", are those compounds wherein w is 0 or 1; n is 1;

Z<sup>100</sup> is BOC, methyl, benzyl or CBZ;

 $R^1$  is hydrogen, -(CH<sub>2</sub>)<sub>q</sub>-(C<sub>3</sub>-C<sub>7</sub>)cycloalkyl, -(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup> or (C<sub>1</sub>-C<sub>10</sub>)alkyl where the (C<sub>1</sub>-C<sub>10</sub>)alkyl and (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl groups are optionally substituted with 1 to 3 fluoro and A<sup>1</sup> in the definition of R<sup>1</sup> is optionally substituted with 1 to 3 substituents independently selected from the group consisting of F, Cl, Me, OMe, CF<sub>3</sub>, OCF<sub>3</sub> and OCF<sub>2</sub>H;

 $R^2$  is hydrogen,  $(C_1-C_8)$ alkyl,  $-(C_0-C_3)$ alkyl- $(C_3-C_7)$ cycloalkyl, phenyl, or  $-(C_1-C_3)$ alkyl-phenyl where the alkyl and phenyl groups are optionally substituted with 1 to 3 substituents independently selected from the group consisting of F,  $CF_3$ , OH and OMe.

A group of compounds preferred among the "CC Group" compounds, designated "DD Group", contains those compounds of "CC Group" wherein  $Z^{100}$  is BOC; w is 1; e is 0;  $R^1$  is -CH<sub>2</sub>-pyridyl, -CH<sub>2</sub>-thiazolyl, or -CH<sub>2</sub>-phenyl optionally substituted with 1 to 3 substituents independently selected from the group consisting of fluoro and chloro; and  $R^2$  is hydrogen, (C<sub>1</sub>-C<sub>4</sub>)alkyl or phenyl where the (C<sub>1</sub>-C<sub>4</sub>)alkyl or phenyl groups in the definition of  $R^2$  is optionally substituted with 1 to 3 substituents independently selected from the group consisting of fluoro, hydroxy and methoxy.

Compounds which are preferred among the "DD Group" compounds is the diastereomeric mixture of a compound wherein R<sup>1</sup> is -CH<sub>2</sub>-phenyl and R<sup>2</sup> is methyl or hydrogen; and the separated 3a-(R) and 3a-(S) isomers are preferred of the diastereomeric mixture.

Yet another group of compounds which are useful in the synthesis of the compounds of formula (I) contains those compounds of the formula

(IV)

the racemic-diastereomeric mixtures and optical isomers of said compounds wherein Z<sup>200</sup> is t-BOC, CBZ, CF<sub>3</sub>C(O)-, FMOC, TROC, trityl, tosyl or optionally substituted benzyl which is optionally substituted with methoxy, dimethoxy or nitro;

e is 0 or 1;

n and w are each independently 0, 1 or 2, provided that w and n cannot both be 0 at the same time;

15 Y is oxygen or sulfur;

 $R^1$  is hydrogen, -CN, -(CH<sub>2</sub>)<sub>q</sub>N(X<sup>6</sup>)C(O)X<sup>6</sup>, -(CH<sub>2</sub>)<sub>q</sub>N(X<sup>6</sup>)C(O)(CH<sub>2</sub>)<sub>1</sub>-A<sup>1</sup>,

 $-(CH_2)_qN(X^6)SO_2(CH_2)_t-A^1, \ -(CH_2)_qN(X^6)SO_2X^6, \ -(CH_2)_qN(X^6)C(O)N(X^6)(CH_2)_t-A^1, \ -(CH_2)_qN(X^6)SO_2X^6, \ -(CH_2)_qN(X^6)SO_2X^6, \ -(CH_2)_qN(X^6)C(O)N(X^6)(CH_2)_t-A^1, \ -(CH_2)_qN(X^6)SO_2X^6, \ -(CH_2)_qN(X^6)C(O)N(X^6)(CH_2)_t-A^1, \ -(CH_2)_qN(X^6)(CH_2)_t-A^1, \ -(CH_2)_qN(X^6)(CH_2)_t-A^1,$ 

 $-(CH_2)_q N(X^6) C(O) N(X^6) (X^6), -(CH_2)_q C(O) N(X^6) (X^6), -(CH_2)_q C(O) N(X^6) (CH_2)_l -A^1,$ 

 $-(CH_2)_qC(O)OX^6$ ,  $-(CH_2)_qC(O)O(CH_2)_l-A^1$ ,  $-(CH_2)_qOX^6$ ,  $-(CH_2)_qOC(O)X^6$ ,

20 -(CH<sub>2</sub>)<sub>0</sub>OC(O)(CH<sub>2</sub>)<sub>1</sub>-A<sup>1</sup>, -(CH<sub>2</sub>)<sub>0</sub>OC(O)N(X<sup>6</sup>)(CH<sub>2</sub>)<sub>1</sub>-A<sup>1</sup>, -(CH<sub>2</sub>)<sub>0</sub>OC(O)N(X<sup>6</sup>)(X<sup>6</sup>),

 $-(CH_2)_0C(O)X^6$ ,  $-(CH_2)_0C(O)(CH_2)_t-A^1$ ,  $-(CH_2)_0N(X^6)C(O)OX^6$ ,

 $-(CH_2)_0N(X^6)SO_2N(X^6)(X^6), -(CH_2)_0S(O)_mX^6, -(CH_2)_0S(O)_m(CH_2)_1-A^1,$ 

 $-(C_1-C_{10})$ alkyl,  $-(CH_2)_t-A^1$ ,  $-(CH_2)_a-(C_3-C_7)$ cycloalkyl,  $-(CH_2)_a-Y^1-(C_1-C_8)$ alkyl,

 $-(CH_2)_q-Y^1-(CH_2)_t-A^1$  or  $-(CH_2)_q-Y^1-(CH_2)_t-(C_3-C_7)$ cycloalkyl;

where the alkyl and cycloalkyl groups in the definition of R<sup>1</sup> are optionally substituted with (C<sub>1</sub>-C<sub>4</sub>)alkyl, hydroxyl, (C<sub>1</sub>-C<sub>4</sub>)alkoxy, carboxyl, CONH<sub>2</sub>, -S(O)<sub>m</sub>(C<sub>1</sub>-C<sub>6</sub>)alkyl, -CO<sub>2</sub>(C<sub>1</sub>-C<sub>4</sub>)alkyl ester, 1H-tetrazol-5-yl or 1 to 3 fluoro;

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 $Y^1 \text{ is O, } S(O)_m, -C(O)NX^6, -CH=CH-, -C\equiv C-, -N(X^6)C(O), -C(O)NX^6, \\ -C(O)O, -OC(O)N(X^6) \text{ or } -OC(O); \\ q \text{ is 0, 1, 2, 3 or 4;} \\ t \text{ is 0, 1, 2 or 3;}$ 

said  $(CH_2)_q$  group and  $(CH_2)_t$  group may each be optionally substituted with hydroxyl,  $(C_1-C_4)$ alkoxy, carboxyl,  $-CONH_2$ ,  $-S(O)_m(C_1-C_6)$ alkyl,

 $-CO_2(C_1-C_4)$ alkyl, 1H-tetrazol-5-yl, 1 to 3 fluoro or 1 or 2 ( $C_1-C_4$ )alkyl;

 $R^2$  is hydrogen,  $(C_1-C_8)$ alkyl,  $-(C_0-C_3)$ alkyl- $(C_3-C_8)$ cycloalkyl,  $-(C_1-C_4)$ alkyl- $A^1$  or  $A^1$ ; where the alkyl groups and the cycloalkyl groups in the definition of  $R^2$  are optionally substituted with hydroxyl,  $-C(O)OX^6$ ,  $-C(O)N(X^6)(X^6)$ ,  $-N(X^6)(X^6)$ ,  $-S(O)_m(C_1-C_6)$ alkyl,  $-C(O)A^1$ ,  $-C(O)(X^6)$ ,  $CF_3$ , CN or 1 to 3 halogen;

 $R^3$  is  $A^1$ ,  $(C_1-C_{10})$ alkyl,  $-(C_1-C_6)$ alkyl- $A^1$ ,  $-(C_1-C_6)$ alkyl- $(C_3-C_7)$ cycloalkyl,  $-(C_1-C_5)$ alkyl- $X^1-(C_1-C_5)$ 

where the alkyl groups in the definition of  $R^3$  is optionally substituted with  $-S(O)_m(C_1-C_6)$ alkyl,  $-C(O)OX^3$ , 1 to 5 halogens or 1 to 3  $OX^3$ ;  $X^1$  is O,  $S(O)_m$ ,  $-N(X^2)C(O)$ -,  $-C(O)N(X^2)$ -, -OC(O)-, -C(O)O-,  $-CX^2=CX^2$ -,  $-N(X^2)C(O)O$ -,  $-OC(O)N(X^2)$ - or  $-C\equiv C$ -;

 $R^4$  is hydrogen,  $(C_1-C_8)$ alkyl or  $(C_3-C_7)$ cycloalkyl, or  $R^4$  is taken together with  $R^3$  and the carbon atom to which they are attached and form  $(C_5-C_7)$ cycloalkyl,  $(C_5-C_7)$ cycloalkenyl, a partially saturated or fully saturated 4- to 8-membered ring having 1 to 4 heteroatoms independently selected from the group consisting of oxygen, sulfur and nitrogen, or is a bicyclic ring system consisting of a partially saturated or fully saturated 5- or 6-membered ring, fused to a partially saturated, fully unsaturated or fully saturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen;  $X^4$  is hydrogen or  $(C_1-C_8)$ alkyl or  $X^4$  is taken together with  $R^4$  and the nitrogen atom to which  $X^4$  is attached and the carbon atom to which  $R^4$  is attached and form a five to seven membered ring:

$$Z^{1} \qquad \qquad Z^{5} \qquad X^{5a}$$
30 R<sup>6</sup> is a bond or is

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where a and b are independently 0, 1, 2 or 3;

 $X^5$  and  $X^{5a}$  are each independently selected from the group consisting of hydrogen, trifluoromethyl,  $A^1$  and optionally substituted ( $C_1$ - $C_6$ )alkyl;

the optionally substituted  $(C_1-C_6)$ alkyl in the definition of  $X^5$  and  $X^{5a}$  is optionally substituted with a substituent selected from the group consisting of  $A^1$ ,  $-OX^2$ ,  $-S(O)_m(C_1-C_6)$ alkyl,  $-C(O)OX^2$ ,

 $(C_3-C_7)$ cycloalkyl,  $-N(X^2)(X^2)$  and  $-C(O)N(X^2)(X^2)$ ;

or the carbon bearing  $X^5$  and  $X^{5a}$  forms an alkylene bridge with the nitrogen atom bearing  $Z^{200}$  and  $R^8$  where the alkylene bridge contains 1 to 5 carbon atoms provided that  $X^5$  or  $X^{5a}$  but not both may be on the carbon atom and  $Z^{200}$  or  $R^8$  but not both may be on the nitrogen atom;

or X<sup>5</sup> is taken together with X<sup>5a</sup> and the carbon atom to which they are attached and form a partially saturated or fully saturated 3- to 7-membered ring, or a partially saturated or fully saturated 4- to 8-membered ring having 1 to 4 heteroatoms independently selected from the group consisting of oxygen, sulfur and nitrogen;

or X<sup>5</sup> is taken together with X<sup>5a</sup> and the carbon atom to which they are attached and form a bicyclic ring system consisting of a partially saturated or fully saturated 5- or 6-membered ring, optionally having 1 or 2 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen, fused to a partially saturated, fully saturated or fully unsaturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen;

 $Z^1$  is a bond, O or N-X<sup>2</sup>, provided that when a and b are both 0 then  $Z^1$  is not N-X<sup>2</sup> or O:

R<sup>8</sup> is hydrogen or optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl;

where the optionally substituted  $(C_1-C_6)$  alkyl in the definition of  $R^8$  is optionally independently substituted with  $A^1$ ,  $-C(O)O-(C_1-C_6)$  alkyl,

 $-S(O)_m(C_1-C_6)$ alkyl, 1 to 5 halogens, 1 to 3 hydroxy, 1 to 3  $-O-C(O)(C_1-C_{10})$ alkyl or 1 to 3  $(C_1-C_6)$ alkoxy; or

 $A^1$  for each occurrence is independently ( $C_5$ - $C_7$ )cycloalkenyl, phenyl or a partially saturated, fully saturated or fully unsaturated 4- to 8-m mbered ring optionally having 1 to 4 heteroatoms independently selected from the group consisting of

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oxygen, sulfur and nitrogen, or a bicyclic ring system consisting of a partially saturated, fully unsaturated or fully saturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen, fused to a partially saturated, fully saturated or fully unsaturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen;

A¹ for each occurrence is independently optionally substituted, in one or optionally both rings if A¹ is a bicyclic ring system, with up to three substituents, each substituent independently selected from the group consisting of F, Cl, Br, I, OCF<sub>3</sub>, OCF<sub>2</sub>H, CF<sub>3</sub>, CH<sub>3</sub>, OCH<sub>3</sub>,  $-OX^6$ ,  $-C(O)N(X^6)(X^6)$ ,  $-C(O)OX^6$ , oxo,  $(C_1-C_6)$ alkyl, nitro, cyano, benzyl,  $-S(O)_m(C_1-C_6)$ alkyl, 1H-tetrazol-5-yl, phenyl, phenoxy, phenylalkyloxy, halophenyl, methylenedioxy,  $-N(X^6)(X^6)$ ,  $-N(X^6)C(O)(X^6)$ ,  $-SO_2N(X^6)(X^6)$ ,  $-N(X^6)SO_2$ -phenyl,  $-N(X^6)SO_2X^6$ ,  $-CONX^{11}X^{12}$ ,  $-SO_2NX^{11}X^{12}$ ,  $-NX^6SO_2X^{12}$ ,  $-NX^6CONX^{11}X^{12}$   $-NX^6SO_2NX^{11}X^{12}$  and

-NX $^6$ CONX $^{11}$ X $^{12}$ , -NX $^6$ SO $_2$ NX $^{11}$ X $^{12}$ , -NX $^6$ C(O)X $^{12}$ , imidazolyl, thiazolyl and tetrazolyl, provided that if A $^1$  is optionally substituted with methylenedioxy then it can only be substituted with one methylenedioxy;

where X<sup>11</sup> is hydrogen or optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl;

the optionally substituted  $(C_1-C_6)$ alkyl defined for  $X^{11}$  is optionally independently substituted with phenyl, phenoxy,  $(C_1-C_6)$ alkoxycarbonyl,  $-S(O)_m(C_1-C_6)$ alkyl, 1 to 5 halogens, 1 to 3 hydroxy, 1 to 3  $(C_1-C_{10})$ alkanoyloxy or 1 to 3  $(C_1-C_6)$ alkoxy;

 $X^{12}$  is hydrogen, (C<sub>1</sub>-C<sub>6</sub>)alkyl, phenyl, thiazolyl, imidazolyl, furyl or thienyl, provided that when  $X^{12}$  is not hydrogen,  $X^{12}$  is optionally substituted with one to three substituents independently selected from the group consisting of Cl, F, CH<sub>3</sub>, OCH<sub>3</sub>, OCF<sub>3</sub> and CF<sub>3</sub>;

or  $X^{11}$  and  $X^{12}$  are taken together to form -(CH<sub>2</sub>)<sub>r</sub>-L<sup>1</sup>-(CH<sub>2</sub>)<sub>r</sub>-; L<sup>1</sup> is C(X<sup>2</sup>)(X<sup>2</sup>), O, S(O)<sub>m</sub> or N(X<sup>2</sup>);

r for each occurrence is independently 1, 2 or 3;

30 X<sup>2</sup> for each occurrence is independently hydrogen, optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl, or optionally substituted (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl, where the optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl and optionally substituted (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl in the definition of X<sup>2</sup> are

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optionally independently substituted with  $-S(O)_m(C_1-C_6)$  alkyl,  $-C(O)OX^3$ , 1 to 5 halogens or 1 to 3  $-OX^3$ ;

X<sup>3</sup> for each occurrence is independently hydrogen or (C<sub>1</sub>-C<sub>6</sub>)alkyl;

 $X^6$  for each occurrence is independently hydrogen, optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>2</sub>-C<sub>6</sub>)halogenated alkyl, optionally substituted (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl, (C<sub>3</sub>-C<sub>7</sub>)-halogenated cycloalkyl, where optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl and optionally substituted (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl in the definition of  $X^6$  is optionally independently substituted with hydroxyl, (C<sub>1</sub>-C<sub>4</sub>)alkoxy, carboxyl, CONH<sub>2</sub>, -S(O)<sub>m</sub>(C<sub>1</sub>-C<sub>6</sub>)alkyl, -CO<sub>2</sub>(C<sub>1</sub>-C<sub>4</sub>)alkyl, 1H-tetrazol-5-yl or 1 or 2 (C<sub>1</sub>-C<sub>4</sub>)alkyl; or

when there are two  $X^6$  groups on one atom and both  $X^6$  are  $(C_1-C_6)$ alkyl, the two  $(C_1-C_6)$ alkyl groups may be optionally joined and, together with the atom to which the two  $X^6$  groups are attached, form a 4- to 9- membered ring optionally having oxygen, sulfur or  $NX^7$ :

X<sup>7</sup> is hydrogen or (C<sub>1</sub>-C<sub>6</sub>)alkyl optionally substituted by hydroxyl; and m for each occurrence is independently 0, 1 or 2; with the proviso that:

 $X^6$  and  $X^{12}$  cannot be hydrogen when it is attached to C(O) or SO<sub>2</sub> in the form C(O) $X^6$ , C(O) $X^{12}$ , SO<sub>2</sub> $X^6$  or SO<sub>2</sub> $X^{12}$ ; and

when  $R^6$  is a bond then L is  $N(X^2)$  and each r in the definition - $(CH_2)_r$ -L- $(CH_2)_r$ - is 2 or 3.

Compounds which are preferred of the foregoing compounds of formula (IV) is the compound wherein e is 0; Y is O; R<sup>1</sup> is -CH<sub>2</sub>-phenyl; R<sup>2</sup> is methyl or hydrogen; n is 1; W is 1; R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-phenyl; R<sup>4</sup> is hydrogen; X<sup>4</sup> is hydrogen; R<sup>6</sup> is -C(CH<sub>3</sub>)<sub>2</sub>-; Z<sup>200</sup> is BOC and R<sup>8</sup> is hydrogen.

25 This invention also provides:

a method for increasing levels of endogenous growth hormone in a human or other animal which comprises administering to such human or other animal an effective amount of a compound of Formula I;

- a pharmaceutical composition useful for increasing the endogenous production or release of growth hormone in a human or other animal which comprises an inert carrier and an effective amount of a compound of Formula I;
- a pharmaceutical composition useful for incr asing the endog nous production or release of growth hormone in a human or other animal which

WO 97/24369 PCT/IB96/01353

comprises an inert carrier, an effective amount of a compound of Formula I and another growth hormone secretagogue such as, GHRP-6, Hexarelin, GHRP-1, IGF-1, IGF-2, B-HT920 or growth hormone releasing factor (GRF) or an analog thereof:

a method for the treatment or prevention of osteoporosis which comprises administering to a human or other animal in need of such treatment or prevention an amount of a compound of Formula I which is effective in treating or preventing osteoporosis;

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a method for the treatment or prevention of osteoporosis which comprises administering to a human or other animal with osteoporosis a combination of a bisphosphonate compound such as alendronate, and especially preferred is the bisphosphonate compound ibandronate, and a compound of Formula I;

a method for the treatment or prevention of osteoporosis which comprises administering to a human or other animal with osteoporosis a combination of estrogen or Premarin® and a compound of Formula I and optionally progesterone;

a method to increase IGF-1 levels in IGF-1 deficient humans or other animals which comprises administering to a human or other animal with IGF-1 deficiency a compound of Formula I;

a method for the treatment of osteoporosis which comprises administering to a human or other animal with osteoporosis a combination of an estrogen agonist or antagonist such as tamoxifen, droloxifene, raloxifene and idoxifene and a compound of Formula I;

a particularly preferred method for the treatment of osteoporosis comprises administering to a human or other animal with osteoporosis a combination of an estrogen agonist or antagonist such as Cis-6-(4-fluoro-phenyl)-5-[4-(2-piperidin-1-ylethoxy)-phenyl]-5,6,7,8-tetrahydro-naphthalene-2-ol;

(-)-cis-6-phenyl-5-[4-(2-pyrrolidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydronaphthalene-2-ol;

cis-6-phenyl-5-[4-(2-pyrrolidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydronaphthalene-2-ol;

cis-1-[6'-pyrrolodinoethoxy-3'-pyridyl]-2-phenyl-6-hydroxy-1,2,3,4-tetrahydronaphthalene;

1-(4'-pyrrolidinoethoxyphenyl)-2-(4"-fluorophenyl)-6-hydroxy-1,2,3,4tetrahydroisoquinoline;

*cis*-6-(4-hydroxyphenyl)-5-[4-(2-piperidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydro-naphthalene-2-ol; or

1-(4'-pyrrolidinolethoxyphenyl)-2-phenyl-6-hydroxy-1,2,3,4-tetrahydro-isoquinoline and a compound of Formula I;

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a method for the treatment of osteoporosis which comprises administering to a human or other animal with osteoporosis a combination of calcitonin and a compound of Formula 1;

a method for increasing muscle mass, which method comprises administering to a human or other animal in need of such treatment an amount of a compound of Formula I which is effective in promoting release of endogenous growth hormone; and

a method for promoting growth in growth hormone deficient children which comprises administering to a growth hormone deficient child a compound of Formula I which is effective in promoting release of endogenous growth hormone.

This invention further provides a method for treating or preventing diseases or conditions which may be treated or prevented by growth hormone which comprises administering to a human or other animal in need of such treatment or prevention an amount of a compound of Formula I which is effective in promoting release of endogenous growth hormone.

In another aspect, this invention provides methods for treating or preventing congestive heart failure, frailty associated with aging, and obesity which comprise administering to a human or other animal in need of such treatment or prevention an amount of a compound of Formula I which is effective in promoting release of endogenous growth hormone; of the instant method it is preferred that the disease or condition to be treated or prevented is congestive heart failure or frailty associated with aging.

In another aspect, this invention provides methods for accelerating bone fracture repair, attenuating protein catabolic response after a major operation, reducing cachexia and protein loss due to chronic illness such as AIDS and cancer, accelerating wound healing, and accelerating the recovery of burn patients or patients having undergone major surgery, which comprise administering to a human or other animal in need of such treatment an amount of a compound of Formula I which is effective in promoting release of endogenous growth hormone; of the instant

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method a preferred method of use is to accelerate bone fracture repair or for accelerating the recovery of patients having undergone major surgery.

In yet another aspect, this invention provides methods for improving muscle strength, mobility, maintenance of skin thickness, metabolic homeostasis and renal homeostasis, which comprise administering to a human or other animal in need of such treatment an amount of a compound of claim 1 which is effective in promoting release of endogenous growth hormone.

The instant compounds promote the release of growth hormone which are stable under various physiological conditions and may be administered parenterally, nasally or by the oral route.

## Detailed Description of the Invention

One of ordinary skill will recognize that certain substituents listed in this invention may have reduced chemical stability when combined with one another or with heteroatoms in the compounds. Such compounds with reduced chemical stability are not preferred.

In general the compounds of Formula I can be made by processes which include processes known in the chemical arts for the production of compounds. Certain processes for the manufacture of Formula I compounds are provided as further features of the invention and are illustrated by the following reaction schemes.

In the above structural formulae and throughout the instant application, the following terms have the indicated meanings unless expressly stated otherwise:

The alkyl groups are intended to include those alkyl groups of the designated length in either a straight or branched configuration which may optionally contain double or triple bonds. Exemplary of such alkyl groups are methyl, ethyl, propyl, isopropyl, butyl, sec-butyl, tertiary butyl, pentyl, isopentyl, hexyl, isohexyl, allyl, ethynyl, propenyl, butadienyl, hexenyl and the like.

When the definition C<sub>0</sub>-alkyl occurs in the definition, it means a single covalent bond.

The alkoxy groups specified above are intended to include those alkoxy groups of the designated length in either a straight or branched configuration which may optionally contain double or triple bonds. Exemplary of such alkoxy groups are methoxy, ethoxy, propoxy, isopropoxy, butoxy, isobutoxy, tertiary butoxy, pentoxy,

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isopentoxy, hexoxy, isohexoxy, allyloxy, 2-propynyloxy, isobutenyloxy, hexenyloxy and the like.

The term "halogen" or "halo" is intended to include the halogen atoms fluorine, chlorine, bromine and iodine.

The term "halogenated alkyl" is intended to include an alkyl group as defined hereinabove substituted by one or more halogen atoms as defined hereinabove.

The term "halogenated cycloalkyl" is intended to include a cycloalkyl group substituted by one or more halogen atoms as defined hereinabove.

The term "aryl" is intended to include phenyl and naphthyl and aromatic 5and 6-membered rings with 1 to 4 heteroatoms or fused 5- or 6-membered bicyclic rings with 1 to 4 heteroatoms of nitrogen, sulfur or oxygen. Examples of such heterocyclic aromatic rings are pyridine, thiophene (also known as thienyl), furan, benzothiophene, tetrazole, indole, N-methylindole, dihydroindole, indazole, Nformylindole, benzimidazole, thiazole, pyrimidine, and thiadiazole.

The chemist of ordinary skill will recognize that certain combinations of heteroatom-containing substituents listed in this invention define compounds which will be less stable under physiological conditions (e.g., those containing acetal or aminal linkages). Accordingly, such compounds are less preferred.

The expression "prodrug" refers to compounds that are drug precursors, which following administration, release the drug in vivo via some chemical or physiological process (e.g., a prodrug on being brought to the physiological pH is converted to the desired drug form). Exemplery prodrugs upon cleavage release the corresponding free acid, and such hydrolyzable ester-forming residues of the compounds of this invention include but are not limited to carboxylic acid substituents (e.g.,  $R^1$  is  $-(CH_2)_qC(O)_2X^8$  where  $X^6$  is hydrogen, or  $R^2$  or  $A^1$  contains carboxylic acid) wherein the free hydrogen is replaced by (C<sub>1</sub>-C<sub>4</sub>)alkyl,  $C_{12}$ )alkanoyloxymethyl,  $(C_4-C_9)1-(alkanoyloxy)ethyl, 1-methyl-1-(alkanoyloxy)-ethyl$ having from 5 to 10 carbon atoms, alkoxycarbonyloxymethyl having from 3 to 6 carbon atoms, 1-(alkoxycarbonyloxy)ethyl having from 4 to 7 carbon atoms, 1methyl-1-(alkoxycarbonyloxy)ethyl having from 5 to 8 carbon atoms, (alkoxycarbonyl)aminomethyl having from 3 to 9 carbon atoms, 1-(N-(alkoxycarbonyl)amino)ethyl having from 4 to 10 carbon atoms, 3-phthalidyl, 4gamma-butyrolacton-4-yl, di-N,N-(C<sub>1</sub>-C<sub>2</sub>)alkylamino(C<sub>2</sub>-C<sub>3</sub>)alkyl crotonolactonyl,

WO 97/24369 PCT/IB96/01353

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(such as  $\beta$ -dimethylaminoethyl), carbamoyl-( $C_1$ - $C_2$ )alkyl, N,N-di( $C_1$ - $C_2$ )-alkylcarbamoyl-( $C_1$ - $C_2$ )alkyl and piperidino-, pyrrolidino- or morpholino( $C_2$ - $C_3$ )alkyl.

Other exemplary prodrugs release an alcohol of Formula I wherein the free hydrogen of the hydroxyl substituent (e.g.,  $R^1$  contains hydroxyl) is replaced by ( $C_1$ - $C_6$ )alkanoyloxymethyl, 1-(( $C_1$ - $C_6$ )alkanoyloxy)ethyl, 1-methyl-1-(( $C_1$ - $C_6$ )alkanoyloxy)ethyl,  $(C_1$ - $C_6$ )alkoxycarbonyloxymethyl, N-( $C_1$ - $C_6$ )alkoxy-carbonylaminomethyl, succinoyl, ( $C_1$ - $C_6$ )alkanoyl,  $\alpha$ -amino( $C_1$ - $C_4$ )alkanoyl, arylacetyl and  $\alpha$ -aminoacyl, or  $\alpha$ -aminoacyl- $\alpha$ -aminoacyl wherein said  $\alpha$ -aminoacyl moieties are independently any of the naturally occurring L-amino acids found in proteins,  $P(O)(OH)_2$ ,  $-P(O)(O(C_1$ - $C_6$ )alkyl) $_2$  or glycosyl (the radical resulting from detachment of the hydroxyl of the hemiacetal of a carbohydrate).

Prodrugs of this invention where a carboxyl group in a carboxylic acid of Formula (I) is replaced by an ester may be prepared by combining the carboxylic acid with the appropriate alkyl halide in the presence of a base such as potassium carbonate in an inert solvent such as DMF at a temperature of about 0°C to 100°C for about 1 to about 24 hours. Alternatively, the acid is combined with the appropriate alcohol as solvent in the presence of a catalytic amount of acid such as concentrated sulfuric acid at a temperature of about 20°C to 120°C, preferably at reflux, for about 1 hour to about 24 hours. Another method is the reaction of the acid in an inert solvent such as THF, with concomitant removal of the water being produced by physical (e.g., Dean Stark trap) or chemical (e.g., molecular sieves) means.

Prodrugs of this invention where an alcohol function has been derivatized as an ether may be prepared by combining the alcohol with the appropriate alkyl bromide or iodide in the presence of a base such as potassium carbonate in an inert solvent such as DMF at a temperature of about 0°C to 100°C for about 1 to about 24 hours. Alkanoylaminomethyl ethers may be obtained by reaction of the alcohol with a bis-(alkanoylamino)methane in the presence of a catalytic amount of acid in an inert solvent such as THF, according to a method described in US 4,997,984. Alternatively, these compounds may be prepared by the methods described by Hoffman et al. in J. Org. Chem. 1994, 59, p. 3530.

Certain of the above defined terms may occur more than once in the above formula and upon such occurrence each term shall be defined independently of the other.

Throughout the specification and appendent claims the following 5 abbreviations are used with the following meanings:

•	approvide the area		<del>-</del>
		BOC	t-butyloxycarbonyl
		BOP	Benzotriazol-1-yloxytris(dimethylamino)
	•		phosphonium hexafluorophosphate
		CBZ	Benzyloxycarbonyl
10		CDI	N,N'-Carbonyldiimidazole
		CH <sub>2</sub> Cl <sub>2</sub>	Methylene chloride
		CHCI <sub>3</sub>	Chloroform
		DCC	Dicyclohexylcarbodiimide
		DMF	Dimethylformamide
15		EDC	1-(3-dimethylaminopropyl)-3-
			ethylcarbodiimide hydrochloride
		EtOAc	Ethyl acetate
		FMOC	9-Fluorenylmethoxycarbonyl
		<b>h</b>	hours
20		Hex	Hexane
		HOAT	1-Hydroxy-7-azabenzotriazole
		HOBT	Hydroxybenzotriazole hydrate
		HPLC	High pressure liquid chromatography
		MHz	Megahertz
25		MS	Mass Spectrum
		NMR	Nuclear Magnetic Resonance
		PTH	Parathyroid hormone
		TFA	Trifluoroacetic acid
		THF	Tetrahydrofuran
30		TLC	Thin layer chromatography

-35-

TRH

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Thyrotropin releasing hormone

TROC

2,2,2-Trichloroethoxycarbonyl

The compounds of the instant invention all have at least one asymmetric center as noted by the asterisk in the structural Formula I, above. Additional asymmetric centers may be present on the molecule depending upon the nature of the various substituents on the molecule. Each such asymmetric center will produce two optical isomers and it is intended that all such optical isomers, as separated, pure or partially purified optical isomers, racemic mixtures or diastereomeric mixtures thereof, be included within the scope of the instant invention. In the case of the asymmetric center represented by the asterisk, it has been found that the absolute stereochemistry of the more active and thus more preferred isomer is shown in Formula IA. This preferred absolute configuration also applies to Formula I.

Y
$$\begin{array}{c|c}
 & C \\
 & X^4 \\
 &$$

With the R<sup>4</sup> substituent as hydrogen, the spatial configuration of the asymmetric center corresponds to that in a D-amino acid. In most cases this is also designated an R-configuration although this will vary according to the values of R<sup>3</sup> and R<sup>4</sup> used in making R- or S-stereochemical assignments.

The instant compounds are generally isolated in the form of their pharmaceutically acceptable acid addition salts, such as the salts derived from using inorganic and organic acids. Examples of such acids are hydrochloric, nitric, sulfuric, phosphoric, formic, acetic, trifluoroacetic, propionic, maleic, succinic, D-tartaric, L-tartaric, malonic, methane sulfonic and the like. In addition, certain compounds containing an acidic function such as a carboxy can be isolated in the form of their inorganic salt in which the counter-ion can be selected from sodium, potassium, lithium, calcium, magnesium and the like, as well as from organic bases.

The pharmaceutically acceptable salts are formed by taking about 1 equivalent of a compound of formula (I) and contacting it with about 1 equivalent of

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the appropriate corresponding acid of the salt which is desired. Work-up and isolation of the resulting salt is well-known to those of ordinary skill in the art.

The growth hormone releasing compounds of Formula I are useful in vitro as unique tools for understanding how growth hormone secretion is regulated at the pituitary level. This includes use in the evaluation of many factors thought or known to influence growth hormone secretion such as age, sex, nutritional factors, glucose, amino acids, fatty acids, as well as fasting and non-fasting states. In addition, the compounds of this invention can be used in the evaluation of how other hormones modify growth hormone releasing activity. For example, it has already been established that somatostatin inhibits growth hormone release.

The compounds of Formula I can be administered to animals, including humans, to release growth hormone in vivo. The compounds are useful for treatment of symptoms related to GH deficiency; stimulate growth or enhance feed efficiency of animals raised for meat production to improve carcass quality; to increase milk production in dairy cattle; improvement of bone or wound healing and improvement in vital organ function. The compounds of the present invention by inducing endogenous GH secretion will alter body composition and modify other GHdependent metabolic, immunologic or developmental processes. For example, the compounds of the present invention can be given to chickens, turkeys, livestock animals (such as sheep, pigs, horses, cattle, etc.), companion animals (e.g., dogs) or may have utility in aquaculture to accelerate growth and improve the protein/fat ratio. In addition, these compounds can be administered to humans in vivo as a diagnostic tool to directly determine whether the pituitary is capable of releasing growth hormone. For example, the compounds of Formula I can be administered in vivo to children. Serum samples taken before and after such administration can be assayed for growth hormone. Comparison of the amounts of growth hormone in each of these samples would be a means for directly determining the ability of the patient's pituitary to release growth hormone.

Accordingly, the present invention includes within its scope pharmaceutical compositions comprising, as an active ingredient, at least one of the compounds of Formula I in association with a pharmaceutically acceptable carrier. Optionally, the pharmaceutical compositions can further comprise an anabolic agent in addition to at least one of the compounds of Formula I or another compound which exhibits a

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different activity, e.g., an antibiotic growth permittant or an agent to treat osteoporosis or with other pharmaceutically active materials wherein the combination enhances efficacy and minimizes side effects.

Growth promoting and anabolic agents include, but are not limited to, TRH, PTH, diethylstilbesterol, estrogens, ß-agonists, theophylline, anabolic steroids, enkephalins, E series prostaglandins, compounds disclosed in U.S. Patent No. 3,239,345, the disclosure of which is hereby incorporated by reference, e.g., zeranol; compounds disclosed in U.S. Patent No. 4,036,979, the disclosure of which is hereby incorporated by reference, e.g., sulbenox; and peptides disclosed in U.S. Patent No. 4,411,890, the disclosure of which is hereby incorporated by reference.

The growth hormone secretagogues of this invention in combination with other growth hormone secretagogues such as the growth hormone releasing peptides GHRP-6 and GHRP-1 as described in U.S. Patent No. 4,411,890, the disclosure of which is hereby incorporated by reference, and publications WO 89/07110, WO 89/07111 and B-HT920 as well as hexarelin and the newly discovered GHRP-2 as described in WO 93/04081 or growth hormone releasing hormone (GHRH, also designated GRF) and its analogs or growth hormone and its analogs or somatomedins including IGF-1 and IGF-2 or µ-adrenergic agonists such as clonidine or serotonin 5HTID agonists such as sumitriptan or agents which inhibit somatostatin or its release such as physostigmine and pyridostigmine, are useful for increasing the endogenous levels of GH in mammals. The combination of a GH secretagogue of this invention with GRF results in synergistic increases of endogenous growth hormone.

As is well known to those skilled in the art, the known and potential uses of growth hormone are varied and multitudinous [See "Human Growth Hormone", Strobel and Thomas, Pharmacological Reviews, 46, pg. 1-34 (1994); T. Rosen et al., Horm Res, 1995; 43: pp. 93-99; M. Degerblad et al., European Journal of Endocrinology, 1995, 133: pp.180-188; J. O. Jorgensen, European Journal of Endocrinology, 1994, 130: pp. 224-228; K. C. Copeland et al., Journal of Clinical Endocrinology and Metabolism, Vol. 78 No. 5, pp. 1040-1047; J. A. Aloi et al., Journal of Clinical Endocrinology and Metabolism, Vol. 79 No. 4, pp. 943-949; F. Cordido et al., Metab. Clin. Exp., (1995), 44(6), pp. 745-748; K. M. Fairhall et al., J. End crin I., (1995).145(3). DD. 417-426: RM. Frieboes et al..

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Neuroendocrinology, (1995), 61(5), pp. 584-589; and M. Llovera et al., Int. J. Cancer, (1995), 61(1), pp. 138-141]. Thus, the administration of the compounds of this invention for purposes of stimulating the release of endogenous growth hormone can have the same effects or uses as growth hormone itself. These varied uses of growth hormone may be summarized as follows: stimulating growth hormone release in elderly humans, treating growth hormone deficient adults; preventing catabolic side effects of glucocorticoids, treating osteoporosis, stimulating the immune system, acceleration of wound healing, accelerating bone fracture repair, treating growth retardation, treating congestive heart failure as disclosed in PCT publications WO 95/28173 and WO 95/28174 (an example of a method for assaying growth hormone secretagogues for efficacy in treating congestive heart failure is disclosed in R. Yang et al., Circulation, Vol. 92, No. 2, p.262, 1995), treating acute or chronic renal failure or insufficiency, treatment of physiological short stature, including growth hormone deficient children, treating short stature associated with chronic illness, treating obesity, treating growth retardation associated with Prader-Willi syndrome and Turner's syndrome; accelerating the recovery and reducing hospitalization of burn patients or following major surgery such as gastrointestinal surgery: treating intrauterine growth retardation, skeletal dysplasia, hypercortisonism and Cushings syndrome; replacing growth hormone in stressed patients; treating osteochondrodysplasias, Noonans syndrome, sleep disorders, Alzheimer's disease, delayed wound healing, and psychosocial deprivation; treating of pulmonary dysfunction and ventilator dependency; attenuating protein catabolic response after a major operation; treating malabsorption syndromes, reducing cachexia and protein loss due to chronic illness such as cancer or AIDS; accelerating weight gain and protein accretion in patients on TPN (total parenteral nutrition); treating hyperinsulinemia including nesidioblastosis; adjuvant treatment for ovulation induction and to prevent and treat gastric and duodenal ulcers; stimulating thymic development and preventing age-related decline of thymic function; adjunctive therapy for patients on chronic hemodialysis; treating immunosuppressed patients and enhancing antibody response following vaccination; improving muscle strength, increasing muscle mass, mobility, maintenance of skin thickness, metabolic home stasis, renal h meostasis in the frail elderly; stimulating ost oblasts, bone remodelling, and cartilag growth; treating neurological diseases such as peripheral

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and drug induced neuropathy, Guillian-Barre Syndrome, amyotrophic lateral sclerosis, multiple sclerosis, cerebrovascular accidents and demyelinating diseases; stimulating the immune system in companion animals and treating disorders of aging in companion animals; growth promotant in livestock; and stimulating wool growth in sheep.

It will be known to those skilled in the art that there are numerous compounds now being used in an effort to treat the diseases or therapeutic indications enumerated above. Combinations of these therapeutic agents, some of which have also been mentioned above, with the growth promotant, exhibit anabolic and desirable properties of these various therapeutic agents. In these combinations, the therapeutic agents and the growth hormone secretagogues of this invention may be independently and sequentially administered or co-administered in dose ranges from one one-hundredth to one times the dose levels which are effective when these compounds and secretagogues are used singly. Combined therapy to inhibit bone resorption, prevent osteoporosis, reduce skeletal fracture, enhance the healing of bone fractures, stimulate bone formation and increase bone mineral density can be effectuated by combinations of bisphosphonates and the growth hormone secretagogues of this invention, see PCT publication WO 95/11029 for a discussion of combination therapy using bisphosphonates and GH secretagogues. The use of bisphosphonates for these utilities has been reviewed, for example, by Hamdy. N.A.T., Role of Bisphosphonates in Metabolic Bone Diseases, Trends in Endocrinol. Metab., 1993, 4, pages 19-25. Bisphosphonates with these utilities include but are not limited to alendronate, tiludronate, dimethyl-APD, risedronate, etidronate, YM-175, clodronate, pamidronate, and BM-210995 (ibandronate). According to their potency, oral daily dosage levels of the bisphosphonate of between 0.1 mg and 5 g and daily dosage levels of the growth hormone secretagogues of this invention of between 0.01 mg/kg to 20 mg/kg of body weight are administered to patients to obtain effective treatment of osteoporosis.

The compounds of this invention may be combined with a mammalian estrogen agonist/antagonist. Any estrogen agonist/antagonist may be used as the second compound of this invention. The term estrogen agonist/antagonist refers to compounds which bind with the estrogen receptor, inhibit bone turnover and prevent bone loss. In particular, estrogen agonists are herein defined as chemical compounds

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capable of binding to the estrogen receptor sites in mammalian tissue, and mimicking the actions of estrogen in one or more tissue. Estrogen antagonists are herein defined as chemical compounds capable of binding to the estrogen receptor sites in mammalian tissue, and blocking the actions of estrogen in one or more tissues. Such activities are readily determined by those skilled in the art according to standard assays including estrogen receptor binding assays, standard bone histomorphometric and densitometer methods (see Eriksen E.F. et al., Bone Histomorphometry, Raven Press, New York, 1994, pages 1-74; Grier S.J. et. al., The Use of Dual-Energy X-Ray Absorptiometry In Animals, Inv. Radiol., 1996, 31(1):50-62; Wahner H.W. and Fogelman I., The Evaluation of Osteoporosis: Dual Energy X-Ray Absorptiometry in Clinical Practice., Martin Dunitz Ltd., London 1994, pages 1-296). A variety of these compounds are described and referenced below, however, other estrogen Α agonists/antagonists will be known to those skilled in the art. preferred estrogen agonist/antagonist is droloxifene: (phenol, 3-[1-[4[2-(dimethylamino)ethoxy]phenyl]-2-phenyl-1-butenyl]-, (E)-) and associated compounds which are disclosed in U.S. patent 5,047,431 (the disclosure of which is hereby incorporated by reference).

Another preferred estrogen agonist/antagonist is tamoxifen: (ethanamine,2-[-4-(1,2-diphenyl-1-butenyl)phenoxy]-N,N-dimethyl, (Z)-2-, 2-hydroxy-1,2,3-propanetricarboxylate (1:1)) and associated compounds which are disclosed in U.S. patent 4,536,516 (the disclosure of which is hereby incorporated by reference). Another related compound is 4-hydroxy tamoxifen which is disclosed in U.S. patent 4,623,660 (the disclosure of which is hereby incorporated by reference).

Another preferred estrogen agonist/antagonist is raloxifene: (methanone, [6-hydroxy-2-(4-hydroxyphenyl)benzo[b]thien-3-yl][4-[2-(1-piperidinyl)ethoxy]phenyl]-,hydrochloride) and associated compounds which are disclosed in U.S. patent 4,418,068 (the disclosure of which is hereby incorporated by reference).

Another preferred estrogen agonist/antagonist is idoxifene: Pyrrolidine, 1-[-[4-[1-(4-iodophenyl)-2-phenyl-1-Butenyl]phenoxy]ethyl] and associated compounds which are disclosed in U.S. patent 4,839,155 (the disclosure of which is hereby incorporated by reference).

Other preferred estrogen agonist/antagonists include compounds as described in commonly assigned U.S. patent no. 5,552,412 the disclosure of which is hereby

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incorporated by reference. Especially preferred compounds which are described therein are:

cis-6-(4-fluoro-phenyl)-5-[4-(2-piperidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydro-naphthalene-2-ol;

(-)-cis-6-phenyl-5-[4-(2-pyrrolidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydronaphthalene-2-ol;

*cis*-6-phenyl-5-[4-(2-pyrrolidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydronaphthalene-2-ol;

cis-1-[6'-pyrrolodinoethoxy-3'-pyridyl]-2-phenyl-6-hydroxy-1,2,3,4-

10 tetrahydronaphthalene;

1-(4'-pyrrolidinoethoxyphenyl)-2-(4"-fluorophenyl)-6-hydroxy-1,2,3,4-tetrahydroisoquinoline;

*cis*-6-(4-hydroxyphenyl)-5-[4-(2-piperidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydro-naphthalene-2-ol; and

15 1-(4'-pyrrolidinolethoxyphenyl)-2-phenyl-6-hydroxy-1,2,3,4-tetrahydroisoquinoline.

Other estrogen agonist/antagonists are described in U.S. Patent 4,133,814 (the disclosure of which is hereby incorporated by reference). U.S. Patent 4,133,814 discloses derivatives of 2-phenyl-3-aroyl-benzothiophene and 2-phenyl-3-aroylbenzothiophene-1-oxide.

The following paragraphs provide preferred dosage ranges for various antiresorptive agents.

The amount of the anti-resorptive agent to be used is determined by its activity as a bone loss inhibiting agent. This activity is determined by means of an individual compound's pharmacokinetics and its minimal maximal effective dose in inhibition of bone loss using a protocol such as those referenced above.

In general an effective dosage for the activities of this invention, for example the treatment of osteoporosis, for the estrogen agonists/antagonists (when used in combination with a compound of Formula I of this invention) is in the range of 0.01 to 200 mg/kg/day, preferably 0.5 to 100 mg/kg/day.

In particular, an effective dosage for droloxifene is in the range of 0.1 to 40 mg/kg/day, preferably 0.1 to 5 mg/kg/day.

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In particular, an effective dosage for raloxifene is in the range of 0.1 to 100 mg/kg/day, preferably 0.1 to 10 mg/kg/day.

In particular, an effective dosage for tamoxifen is in the range of 0.1 to 100 mg/kg/day, preferably 0.1 to 5 mg/kg/day.

In particular, an effective dosage for

*cis*-6-(4-fluoro-phenyl)-5-[4-(2-piperidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydro-naphthalene-2-ol;

(-)-cis-6-phenyl-5-[4-(2-pyrrolidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydronaphthalene-2-ol;

*cis*-6-phenyl-5-[4-(2-pyrrolidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydronaphthalene-2-ol;

*cis*-1-[6'-pyrrolodinoethoxy-3'-pyridyl]-2-phenyl-6-hydroxy-1,2,3,4-tetrahydronaphthalene;

1-(4'-pyrrolidinoethoxyphenyl)-2-(4"-fluorophenyl)-6-hydroxy-1,2,3,4-tetrahydroisoquinoline;

*cis*-6-(4-hydroxyphenyl)-5-[4-(2-piperidin-1-yl-ethoxy)-phenyl]-5,6,7,8-tetrahydro-naphthalene-2-ol; or

1-(4'-pyrrolidinolethoxyphenyl)-2-phenyl-6-hydroxy-1,2,3,4tetrahydroisoquinoline is in the range of 0.0001 to 100 mg/kg/day, preferably 0.001 to 10 mg/kg/day.

In particular, an effective dosage for 4-hydroxy tamoxifen is in the range of 0.0001 to 100 mg/kg/day, preferably 0.001 to 10 mg/kg/day.

Compounds that have the ability to stimulate GH secretion from cultured rat pituitary cells are identified using the following protocol. This test is also useful for comparison to standards to determine dosage levels. Cells are isolated from pituitaries of 6-week old male Wistar rats. Following decapitation, the anterior pituitary lobes are removed into cold, sterile Hank's balanced salt solution without calcium or magnesium (HBSS). Tissues are finely minced, then subjected to two cycles of mechanically assisted enzymatic dispersion using 10 U/mL bacterial protease (EC 3.4.24.4, Sigma P-6141) in HBSS. The tissue-enzyme mixture is stirred in a spinner flask at 30 rpm in a 5% CO<sub>2</sub> atmosphere at about 37°C for about 30 min, with manual trituration after about 15 min and about 30 min using a 10-mL

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pipet. This mixture is centrifuged at 200 x g for about 5 min. Horse serum is added to the supernatant to neutralize excess protease. The pellet is resuspended in fresh protease, stirred for about 30 min more under the previous conditions, and manually triturated, ultimately through a 23-gauge needle. Again, horse serum is added, then the cells from both digests are combined, pelleted (200 x g for about 15 min), washed, resuspended in culture medium and counted. Cells are plated at 6.0-6.5x10<sup>4</sup> cells per cm<sup>2</sup> in 48-well Costar dishes and cultured for 3-4 days in Dulbecco's Modified Eagle Medium (D-MEM) supplemented with 4.5 g/L glucose, 10% horse serum, 2.5% fetal bovine serum, 1% non-essential amino acids, 100 U/mL nystatin and 50 mg/mL gentamycin sulfate before assaying for GH secretion.

Just prior to assay, culture wells are rinsed twice, then equilibrated for about 30 minutes in release medium (D-MEM buffered with 25 mM Hepes, pH 7.4 and containing 0.5% bovine serum albumin at 37°C). Test compounds are dissolved in DMSO, then diluted into pre-warmed release medium. Assays are run in quadruplicate. The assay is initiated by adding 0.5 mL of release medium (with vehicle or test compound) to each culture well. Incubation is carried out at about 37°C for about 15 minutes, then terminated by removal of the culture medium, which is centrifuged at 2000 x g for about 15 minutes to remove cellular material. Rat growth hormone concentrations in the supernatants are determined by a standard radioimmunoassay protocol using a rat growth hormone reference preparation (NIDDK-rGH-RP-2) and rat growth hormone antiserum raised in monkey (NIDDKanti-rGH-S-5) obtained from Dr. A. Parlow (Harbor-UCLA Medical Center, Torrence, CA). Additional rat growth hormone (1.5U/mg, #G2414, Scripps Labs, San Diego. CA) is iodinated to a specific activity of approximately 30 µCi/µg by the chloramine T method for use as tracer. Immune complexes are obtained by adding goat antiserum to monkey IgG (Organon Teknika, Durham, NC) plus polyethylene glycol, MW 10,000-20,000 to a final concentration of 4.3%; recovery is accomplished by centrifugation. This assay has a working range of 0.08-2.5 µg rat growth hormone per tube above basal levels. Active compounds typically stimulate growth hormone release by greater than 1.4 fold. Reference: Cheng, K., Chan, W.-S., Barreto, Jr., A., Convey, E.M., Smith, R.G. 1989.

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Assay for Exogenously-Stimulated Growth Hormone Release in the Rat after Intravenous Administration of Test Compounds

Twenty-one day old female Sprague-Dawley rats (Charles River Laboratory, Wilmington, MA) are allowed to acclimate to local vivarium conditions (24 °C, 12 hr light, 12 hr dark cycle) for approximately 1 week before compound testing. All rats are allowed access to water and a pelleted commercial diet (Agway Country Food, Syracuse NY) ad libitum. The experiments are conducted in accordance with the NIH Guide for the Care and Use of Laboratory Animals.

On the day of the experiment, test compounds are dissolved in vehicle containing 1% ethanol, 1mM acetic acid and 0.1% bovine serum albumin in saline. Each compound is tested with n=3. Rats are weighed and anesthetized via intraperitoneal injection of sodium pentobarbital (Nembutol, 50 mg/kg body weight). Fourteen minutes after anesthetic administration, a blood sample is taken by nicking the tip of the tail and allowing the blood to drip into a microcentrifuge tube (baseline blood sample, approximately 100 µl). Fifteen minutes after anesthetic administration, test compound is delivered by intravenous injection into the tail vein, with a total injection volume of 1 ml/kg body weight. Additional blood samples are taken from the tail at 5, 10 and 15 minutes after compound administration. Blood samples are kept on ice until serum separation by centrifugation (1430xg for 10 minutes at 10°C). Serum is stored at -80°C until serum growth hormone determination by radio-immunoassay as described above and below.

Assessment of Exogenously-Stimulated Growth Hormone Release in the Dog after Oral Administration

On the day of experimentation, the test compound is weighed out for the appropriate dose and dissolved in water. Doses are delivered at a volume of 0.5 ml/kg by gavage to 4 dogs for each dosing regimen. Blood samples (2 ml) are collected from the jugular vein by direct vena puncture pre-dose and at 0.08, 0.17, 0.25, 0.5, 0.75, 1, 2, 4, 6, and 8 hours post dose using 2 ml vacutainers containing lithium heparin. The prepared plasma is stored at -20 °C until analysis.

#### 30 Measurement of Canine Growth Hormone

Canine growth hormone concentrations are determined by a standard radioimmunoassay protocol using canine growth hormone (antigen for iodination and

reference preparation AFP-1983B) and canine growth hormone antiserum raised in monkey (AFP-21452578) obtained from Dr. A. Parlow (Harbor-UCLA Medical Center, Torrence, CA). Tracer is produced by chloramine T-iodination of canine growth hormone to a specific activity of 20-40 µCi/µg. Immune complexes are obtained by adding goat antiserum to monkey IgG (Organon Teknika, Durham, NC) plus polyethylene glycol, MW 10,000-20,000 to a final concentration of 4.3%; recovery is accomplished by centrifugation. This assay has a working range of 0.08-2.5 µg canine GH/tube.

The compounds of this invention can be administered by oral, parenteral (e.g., intramuscular, intraperitoneal, intravenous or subcutaneous injection, or implant), nasal, vaginal, rectal, sublingual, or topical routes of administration and can be formulated with pharmaceutically acceptable carriers to provide dosage forms appropriate for each route of administration.

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Solid dosage forms for oral administration include capsules, tablets, pills, powders and granules. In such solid dosage forms, the active compound is admixed with at least one inert pharmaceutically acceptable carrier such as sucrose, lactose, or starch. Such dosage forms can also comprise, as is normal practice, additional substances other than such inert diluents, e.g., lubricating agents such as magnesium stearate. In the case of capsules, tablets and pills, the dosage forms may also comprise buffering agents. Tablets and pills can additionally be prepared with enteric coatings.

Liquid dosage forms for oral administration include pharmaceutically acceptable emulsions, solutions, suspensions, syrups, the elixirs containing inert diluents commonly used in the art, such as water. Besides such inert diluents, compositions can also include adjuvants, such as wetting agents, emulsifying and suspending agents, and sweetening, flavoring and perfuming agents.

Preparations according to this invention for parenteral administration include sterile aqueous or non-aqueous solutions, suspensions, or emulsions. Examples of non-aqueous solvents or vehicles are propylene glycol, polyethylene glycol, vegetable oils, such as olive oil and corn oil, gelatin, and injectable organic esters such as ethyl oleate. Such dosage forms may also contain adjuvants such as preserving, wetting, emulsifying, and dispersing agents. They may be sterilized by, for example, filtration through a bacteria-retaining filter, by incorporating sterilizing

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agents into the compositions, by irradiating the compositions, or by heating the compositions. They can also the confactured in the farm of it its collid compositions which can be dissolved in sterile water, or some other sterile injectable medium immediately before use.

Compositions for rectal or vaginal administration are preferably suppositories which may contain, in addition to the active substance, excipients such as cocabutter or a suppository wax.

Compositions for nasal or sublingual administration are also prepared with standard excipients well known in the art.

The dosage of active ingredient in the compositions of this invention may be varied; however, it is necessary that the amount of the active ingredient be such that a suitable dosage form is obtained. The selected dosage depends upon the desired therapeutic effect, on the route of administration, and on the duration of the treatment. Generally, dosage levels of between 0.0001 to 100 mg/kg of body weight daily are administered to humans and other animals, e.g., mammals, to obtain effective release of growth hormone.

A preferred dosage range is 0.01 to 5.0 mg/kg of body weight daily which can be administered as a single dose or divided into multiple doses.

The preparation of the compounds of Formula I of the present invention can be carried out in sequential or convergent synthetic routes. Syntheses detailing the preparation of the compounds of Formula I in a sequential manner are presented in the reaction schemes shown hereinbelow.

Many protected amino acid derivatives are commercially available, where the protecting groups Prt, Z<sup>100</sup> and Z<sup>200</sup> are, for example, BOC, CBZ, benzyl, ethoxycarbonyl groups, CF<sub>3</sub>C(O)-, FMOC, TROC, trityl or tosyl. Other protected amino acid derivatives can be prepared by literature methods. Some 3-oxo-2-carboxyl pyrrolidines, and 4-oxo-3-carboxyl piperidines are commercially available, and many other related pyrrolidines and 4-substituted piperidines are known in the literature.

Many of the schemes illustrated below describe compounds which contain protecting groups Prt,  $Z^{100}$  or  $Z^{200}$ . Benzyloxycarbonyl groups can be removed by a number of methods including, catalytic hydrog nation with hydrogen in the pres nce of a palladium or platinum catalyst in a protic solvent such as methanol. Preferred

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catalysts are palladium hydroxide on carbon or palladium on carbon. Hydrogen pressures from 1-1000 nsi may be employed; pressures from 10 to 70 psi are preferred. Alternatively, the benzyloxycarbonyl group can be removed by transfer hydrogenation.

Removal of BOC protecting groups can be carried out using a strong acid such as trifluoroacetic acid or hydrochloric acid with or without the presence of a cosolvent such as dichloromethane, ethyl acetate, ether or methanol at a temperature of about -30 to 70°C, preferably about -5 to about 35°C.

Benzyl esters of amines can be removed by a number of methods including, catalytic hydrogenation with hydrogen in the presence of a palladium catalyst in a protic solvent such as methanol. Hydrogen pressures from 1-1000 psi may be employed; pressures from 10 to 70 psi are preferred. The addition and removal of these and other protecting groups are discussed by T. Greene in Protective Groups in Organic Synthesis, John Wiley & Sons, New York, 1981.

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SCHEME 1: The protected amino acid derivatives 1 are in many cases commercially available, where the protecting group Prt is, for example, BOC, FMOC or CBZ groups. Other amino acids can be prepared by literature methods.

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As illustrated in Scheme 1, coupling of amines of formula 2 with protected amino acids of formula 1, where Prt is a suitable protecting group, is conveniently carried out in an inert solvent such as dichloromethane or DMF by a coupling reagent such as EDC or DCC in the presence of HOBT or HOAT. In the case where the amine is present as the hydrochloride salt, it is preferable to add one or two equivalents of a suitable bas such as triethylamine to the reaction mixture.

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Alternatively, the coupling can be effected with a coupling reagent such as BOP in an inert solvent such as methanol. Such coupling reactions are generally conducted at temperatures of about -30° to about 80°C, preferably -10° to about 25°C. For a discussion of other conditions used for coupling peptides see Houben-Weyl, Vol. XV, part II, E. Wunsch, Ed., George Theime Verlag, 1974, Stuttgart. Separation of unwanted side products and purification of intermediates is achieved by chromatography on silica gel, employing flash chromatography (W. C. Still, M. Kahn and A. Mitra, J. Org. Chem. 43 2923 1978), by crystallization or by trituration.

Transformation of the compound of formula 3 into intermediates of formula 4 can be carried out by removal of the protecting group Prt as described above. Coupling of intermediates of formula 4 to amino acids of formula 5 can be effected as described above to give intermediates of formula 6. Deprotection of the amine 6 affords compounds of formula 7.

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Alternatively, compounds of formula 7 can be prepared by a convergent route as shown in Scheme 2. Intermediate esters of formula 8 can be prepared by treating amino acids 1, where Prt is a suitable protecting group, with a base such as potassium carbonate followed by an alkyl halide such as iodomethane in a suitable solvent such as DMF. Deprotection of the amine transforms 8 into 9. Alternatively, many amino acids of formula 9 are commercially available. Intermediate 10 is generated by coupling 9 to amino acid 5. The ester of intermediate 10 can be converted to intermediate acid 11 by a number of methods known in the art; for example, methyl and ethyl esters can be hydrolyzed with lithium hydroxide in a protic solvent such as aqueous methanol or aqueous THF at a temperature of about -20° to 120°C, preferably about 0° to 50°C. In addition, removal of a benzyl group can be accomplished by a number of reductive methods including hydrogenation in the presence of platinum or palladium catalyst in a protic solvent such as methanol. Acid 11 can then be coupled to amine 2 to give intermediates of formula 6. Transformation of 6 to 7 can be achieved by removal of the protecting group  $Z^{200}$ .

SCHEME 3: The esters of formula 6 can be converted to intermediate acids of formula 13 by a number of methods known in the art; for example, methyl and ethyl esters can be hydrolyzed with lithium hydroxide in a protic solvent such as aquabus methanol or aqueous THF at a temperature of about -20° to 120°C, preferably about 0° to 50°C. In addition, removal of a benzyl group can be accomplished by a number of reductive methods including hydrogenation in the presence of platinum or palladium catalyst in a protic solvent such as methanol. Coupling the acid 13 to amine 16 generates the intermediates of formula 14. Transformation of 14 to 15 can be achieved by removal of the protecting group Z<sup>200</sup>.

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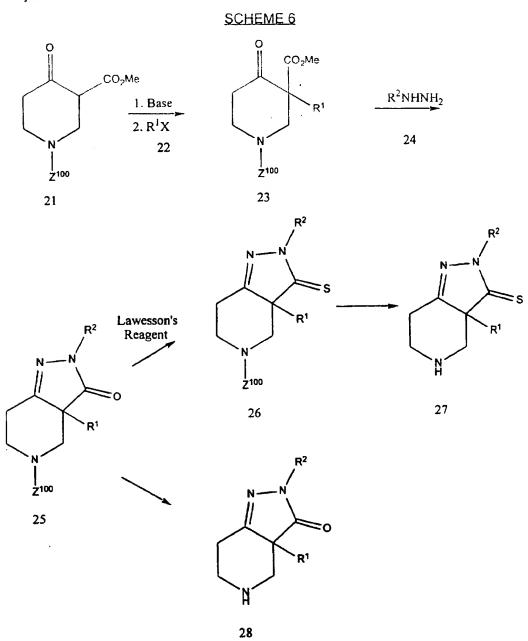
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HO-N

$$R^{8}$$
 $R^{6}$ 
 $R^{6}$ 
 $R^{7}$ 
 $R^{7$ 

SCHEME 4: Esters of formula 17 can be prepared by treating an acid of formula 5 with hydroxysuccinimide in the presence of a coupling agent such as EDC in an inert solvent such as methylene chloride as illustrated in Scheme 4. Treatment of an ester 17 with an amino acid of formula 1 in a solvent such as dioxane, THF or DMF in the presence of a base such as diisopropylethylamine produces 11.

SCHEME 5: As illustrated in Scheme 5, alkylation of the diphenyloxazinone of generates 19 which is then converted to the desired (D)-2-amino-5-phenylpentancia acid 20 by removing the protecting group (Prt) and hydrogenation over a PJCl2 catalyst.



SCHEME 6: Treatment of an ester of formula 21 with a base such as sodium hydride in a solvent such as DMF followed by an alkyl halide 22 generates a

compound of formula 23 as illustrated in Scheme 6. Treating a compound of formula 23 with a hydrazine of formula 24 such as hydrazine or methyl-hydrazine in a coluent such as refluxing ethanol, followed by composited in and her ting the residue in toluene at temperatures at or near reflux results in a compound of formula 25. Alternatively, 23 can be treated with a salt of a hydrazine in the presence of sodium acetate in refluxing ethanol to give 25. Deprotection of the amine generates a compound of formula 28. Thioamides of formula 26 can be formed by treating 25 with Lawesson's reagent in refluxing toluene or benzene. Removal of the protecting group transforms 26 into 27.

10 SCHEME 7

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SCHEME 7: Treatment of a compound of formula 21 with a hydrazine of formula 24 in a solvent such as refluxing ethanol, followed by concentration and heating the residue in toluene at temperatures at or near reflux results in compounds of formula

29. Alternatively, 21 can be treated with a salt of a hydrazine in the presence of sociam about in reflucing ethanol to give 20. The amide of formula 20 can be treated with a base such as sodium hydride in a solvent such as DMF followed by an alkyl halide to give 25. Deprotection of the amine generates a com, conduct formula 28.

$$R^2$$
 $R^2$ 
 $R^3$ 
 $R^4$ 

WO 97/24369 PCT/IB96/01353

-55-

SCHEME 8: Reaction of a ketoester of formula 30 with a chiral amine such as alpha-methylbenzylamine with a suitable aldohyda such as formaldehyde, or reaction of a vinyl ketoester of formula 31 with a chiral amine such as alphamethylbenzylamine with a suitable. Mahyda such as formal 1.1. If rids a compound of formula 32 via a double Mannich reaction. Reaction of 32 with a hydrazine generates a chiral compound of formula 33. Deprotection of the nitrogen with hydrogen and a suitable catalyst such as palladium affords compounds of formula 34.

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SCHEME 9: Treatment of a compound of formula 81 with a reducing agent such as sodium borohydride and protection of the nitrogen affords a compound of formula 82. Protection of the alcohol affords 83. Saponification of the ester affords a compound of formula 84. Reaction of 84 with thionyl chloride followed by treatment with diazomethane affords the homologated acid of formula 85. Esterification of 85 affords a compound of formula 86, which is O-deprotected to give 87. Oxidation of 87 affords a ketone of formula 88. Reaction of 88 with a hydrazine, followed by nitrogen deprotection affords a compound of formula 44.

#### SCHEME 10

SCHEME 10: Treatment of a compound of formula 35 with a base such as sodium hydride in a solvent such as DMF followed by treatment with diethylcarbonate generates the ethyl ester of compound 36. Deprotection of the amine transforms 36 into 37.

## SCHEME 11

SCHEME 11: Treatment of a malonic ester of formula 38 with a base such as sodium hydride in a solvent such as DMF and subsequent hydrogenolysis of the benzyl group with hydrogen and a catalyst such as palladium in a suitable solvent such as methanol produces the ester of formula 39. Deprotection of the amine generates compounds of formula 40.

#### SCHEME 12

$$R_{1}$$
 $R_{2}$ 
 $R_{1}$ 
 $R_{2}$ 
 $R_{1}$ 
 $R_{2}$ 
 $R_{1}$ 
 $R_{2}$ 
 $R_{1}$ 
 $R_{2}$ 
 $R_{1}$ 
 $R_{2}$ 
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 $R_{4}$ 
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 $R_{4}$ 
 $R_{4}$ 
 $R_{4}$ 
 $R_{4}$ 
 $R_{4}$ 

SCHEME 12: Treatment of a ketone of formula 41 with a secondary amine such as piperidine in a suitable solvent such as benzene with removal of water affords an enamine of formula 42. Alkylation of the enamine with an alpha-haloester such as ethylbromoacetate in a suitable solvent such as benzene or THF using a suitable base such as LDA or NaN(SiMe<sub>3</sub>)<sub>2</sub> affords a ketoester of formula 43. Reaction with a hydrazine of formula 24 affords the compound of formula 44. Deprotection of the nitrogen affords compounds of formula 45.

## **SCHEME 13**

Scheme 13: Treatment of a ketoester of formula 37 with an iodonium salt such as diphenyliodonium trifluoroacetate in a suitable solvent such as t-butanol generates a ketoester of formula 46. Reaction of 46 with a hydrazine generates a compound of formula 47. Deprotection of the nitrogen affords compounds of formula 48, see Synthesis, (9), 1984 p. 709 for a detailed description.

## SCHEME 14

SCHEME 14: Treatment of a ketoester of formula 37 with an olefin such as acrylonitrile generates a ketoester of formula 49. Reaction of 49 with a hydrazine generates a compound of formula 50. Deprotection of the nitrogen affords compounds of formula 51.

WO 97/24369 PCT/IB96/01353

-63-

SCHEME 15: Treatment of a ketoester of formula 37 with ally! bromide and a suitable base such as sodium hydride in a suitable solvent such as DMF affords a ketoester of formula 52. Reaction of 52 with a hydrazine generates a compound of formula 53. Ozonolysis of 53 in a suitable solvent such as methylene suitable followed by treatment with a reducing agent such as dimethylsulfide affords an aldehyde of formula 54. Oxidation of 54 affords a carboxylic acid of formula 55. Curtius rearrangement of 55, followed by hydrolysis of the intermediate isocyanate affords a primary amine of formula 56. Treatment of a compound of formula 56 with so living minits on carbamate affords a mea of formula UT. Deprocession of the nitrogen affords compounds of formula 58.

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#### SCHEME 16

$$R^2$$
 $CHO$ 
 $NHX^6$ 
 $NHX^6$ 

SCHEME 16: Treatment of a compound of formula 54 with a primary amine affords an imine of formula 59. Reduction of a compound of formula 59 affords a compound of formula 60. Treatment of a compound of formula 60 with an acylating agent affords a compound of formula 61. Deprotection of the nitrogen affords compounds of formula 62.

WO 97/24369 PCT/IB96/01353

-65-

## SCHEME 17

SCHEME 17: Treatment of a compound of formula 54 with a reducing agent such as sodium borohydride affords a compound of formula 63. Reaction of 63 with an acylating agent such as an isocyanate or carbamate affords compounds of formula 64. Deprotection of the nitrogen affords compounds of formula 65.

-66-

## SCHEME 18

SCHEME 18: Treatment of a compound of formula 63 with a phosphine such as triphenyl phosphine and an azo compound such as diethylazodicarboxylate and an oxindole affords a compound of formula 66. Deprotection of the nitrogen affords the compound of formula 67.

-67-

#### SCHEME 19

SCHEME 19: Treatment of a ketoester of formula 37 with a chiral diol and acid catalyst with removal of water in a suitable solvent such as benzene affords a chiral ketal of formula 68. Alkylation of 68 with an alkyl halide in the presence of a base such as LDA followed by acid-catalyzed hydrolysis of the ketal affords chiral ketoesters of formula 69. R action of 69 with a hydrazin generates chiral

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compounds of formula 70. Deprotection of the nitrogen affords compounds of formula 71.

SCHEME 20: Treatment of a ketoester of formula 37 with a chiral amino acid ester such as valine t-butyl ester affords a chiral enamine of formula 72. Alkylation of 72 with an alkyl halide in the presence of a base such as LDA followed by acid-catalyzed hydrolysis of the enamine affords chiral ketoesters of formula 69. Reaction of 69 with a hydrazine generates chiral compounds of formula 70.

10 Deprotection of the nitrogen affords compounds of formula 71.

#### SCHEME 21

SCHEME 21: Deprotection of the nitrogen of 25 affords compounds of formula 28. Salt formation of 28 with a chiral acid affords a mixture of diastereomeric salts of formula 73. Crystallization of the diastereomeric salts affords the acid salt of chiral

compounds of formula 70. Decomposition of the salt 70 with base liberates chiral compounds of formula 71.

# SCHEME 22

5 SCHEME 22: Alkylation of compounds of formula 25 with an allylic acetate in the presence of a suitable catalyst such as palladium tetrakis(triphenylphosphine) affords compounds of formula 74. Deprotection of the nitrogen affords compounds of formula 75, see Tetrahedron (50) p. 515, 1994 for a detailed discussion.

## SCHEME 23

SCHEME 23: Treatment of a ketodiester of formula 76 with an alkyl halide in the presence of a base such as sodium hydride followed by acid-catalyzed hydrolysis and decarboxylation, followed by esterification with methyliodide and a suitable base affords a compound of formula 77. Reaction of a compound of formula 77 with a suitable aldehyde such as formaldehyde and benzylamine affords a compound of

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formula 78. Reaction of a compound of formula 78 with a hydrazine generates chiral compounds of formula 79. Deprotection of the nitrogen affords compounds of formula 80.

## SCHEME 24

SCHEME 24: Treatment of an amine of formula 23 with an acid of formula 11 in an inert solvent such as dichloromethane or DMF by a coupling reagent such as EDC or DCC in the presence of HOBT affords compounds of formula 89. Reaction of compounds of formula 89 with a hydrazine generates compounds of formula 6. Deprotection of the nitrogen affords compounds of formula 7.

# SCHEME 25

SCHEME 25: Treatment of a hydroxyacetoacetate ester of formula 90 with an alkyl halide in the presence of a suitable base such as sodium hydride affords compounds of formula 91. Reaction of 91 with a hydrazine generates compounds of formula 92. O-Alkylation of the carbonyl oxygen of 92 affords 93 which is converted to the halide 94. Displacement of the halide X by cyanide ion affords the

nitrile 95. Reduction of 95 gives the primary amine 96 which is deprotected and cyclized in the presence of formaldehyde to afford 28.

## SCHEME 26

5 SCHEME 26: Treatment of a beta-keto-protected aminovalerate such as 97 with an alkyl halide in the presence of a suitable base such as sodium hydride affords compounds of formula 98. Reaction of compounds of formula 98 with a hydrazine generates compounds of formula 99. Deprotection of compounds of formula 99 affords primary amines of formula 100. Cyclization of compounds of formula 100 in the presence of formaldehyde affords compounds of formula 28.

# SCHEME 27

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SCHEME 27: Treatment of the amine of formula 23a with an acid such as 1 in the presence of EDC and HOAT in a suitable solvent provides keto-esters of formula 23b. The kinto-ester 23b can be treated with a call of hydrazina in the presence of sodium acetate in refluxing ethanolite of any disclines of formula 10 miles and under suitable conditions gives amines of formula 4. Courting of intermediates of formula 4 to amino acids of formula 5 can be effected as described above to give intermediates of formula 6. Deprotection of amine 6 affords compounds of formula 7.

The following examples are provided for the purpose of further illustration only and are not intended to be limitations on the disclosed invention.

#### **General Experimental Procedures:**

Amicon silica 30 μM, 60 Å pore size, was used for column chromatography. Melting points were taken on a Buchi 510 apparatus and are uncorrected. Proton and carbon NMR spectra were recorded on a Varian XL-300, Bruker AC-300, Varian Unity 400 or Bruker AC-250 at 25 °C. Chemical shifts are expressed in parts per million down field from trimethylsilane. Particle beam mass spectra were obtained on a Hewlett-Packard 5989A spectrometer using ammonia as the source of chemical ionization. For initial sample dissolution, chloroform or methanol was employed. Liquid secondary ion mass spectra (LSIMS) were obtained on a Kratos Concept-1S high resolution spectrometer using cesium ion bombardment on a sample dissolved in a 1:5 mixture of dithioerythritol and dithiothreitol or in a thioglycerol matrix. For initial sample dissolution chloroform or methanol was employed. Reported data are sums of 3-20 scans calibrated against cesium iodide. TLC analyses were performed using E. Merck Kieselgel 60 F254 silica plates visualized (after elution with the indicated solvent(s)) by staining with 15% ethanolic phosphomolybdic acid and heating on a hot plate.

General Procedure A (Peptide coupling using EDC): A 0.2-0.5 M solution of the primary amine (1.0 equivalent) in dichloromethane (or a primary amine hydrochloride and 1.0-1.3 equivalents of triethylamine) is treated sequentially with 1.0-1.2 equivalents of the carboxylic acid coupling partner, 1.5-1.8 equivalents hydroxybenzotriazole hydrate (HOBT) or HOAT and 1.0-1.2 equivalents (stoichiometrically equivalent to the quantity of carboxylic acid) 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (EDC) and the mixture is

stirred overnight in an ice bath (the ice bath is allowed to warm, thus the reaction mixture is typically held at about 0-20 °C for about 4-6 h and about 20-25 °C for the remaining period). The mixture is distinct with athyl acetate or other policies as specified and the resulting mixture washed twice with 1N NaOH, twice with 1N HCI (if the product is not basic) once with bring distributed the CO continue of the component can be used as the dispulsions, lamine salt in coupling to dispulsionary amine or hydrochloride of the latter; in this case no triethylamine is employed.

#### Example 1

- 2-Amino-N-{1(R)-benzyloxymethyl-2-[3a-(R)-(4-fluoro-benzyl)-2-methyl-3-oxo-2.3.3a,4,6.7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-2-oxo-ethyl}-isobutyramide hydrochloride and
  - 2-Amino-N-{1(R)-benzyloxymethyl-2-[3a-(S)-(4-fluoro-benzyl)-2-methyl-3-oxo-2.3.3a,4.6.7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl]-2-oxo-ethyl}-isobutyramide

#### 15 hydrochloride

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- A. 4-Oxo-piperidine-1.3-dicarboxylic acid 1-tert-butyl ester 3-ethyl ester

  A mixture of 8.00 g (38.5 mmol) of 4-oxo-piperidine-3-carboxylic acid ethyl ester
  hydrochloride, 9.23 g (42.4 mmol) of di-tert-butyldicarbonate, and 3.89 g (38.5 mmol)
  of triethylamine in 150 mL of THF was stirred at room temperature for about 72 h.

  The mixture was concentrated and the residue was dissolved in ethyl acetate and
  washed three times each with 10% aqueous HCl, saturated aqueous sodium
  bicarbonate solution, and brine, dried over MgSO<sub>4</sub>, and concentrated to give 10.0 g
  of 1A as a white solid. MS (Cl, NH<sub>3</sub>) 272 (MH<sup>+</sup>).
  - B. 3-(R,S)-(4-Fluoro-benzyl)-4-oxo-piperidine-1.3-dicarboxylic acid 1-tert-butyl ester 3-ethyl ester

To a solution of 2.00 g (7.4 mmol) 1A in 10 mL of DMF was added 282 mg (7.4 mmol) of sodium hydride (60% oil dispersion) and the mixture was stirred at room temperature for about 15 min. A solution of 1.39 g (7.4 mmol) 4-fluorobenzyl bromide in 7 mL of DMF was added to the stirring solution and the mixture was stirred for about 72 h at room temperature. The mixture was diluted with ethyl acetate and washed once with water and four times with brine, dried over MgSO<sub>4</sub>, and concentrated to giv 2.8 g of 1B. MS (CI, NH<sub>3</sub>) 380 (MH<sup>+</sup>).

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C. 33 (R.S) (1-Fluoro-benzyl) 2 mathyl 3 axo 2.2.33 4.9.7 havabyden pyrazoto[4,3-c]pyridine-5-carboxylic acid furt-butyl ester

A mixture of 2.0 + g (6.7 minut) or ratio, a cut 2 to (0.7 minut) of 4.5 to 7.7 to 1.5 to 1.0 mL of ethanul was heated at ruffux for about 0 ht. The minutes were concentrated to 2.0 to 2.5 to 1.5 to

the mixture was concentrated and the residue was purified by since get chromatography using an elution gradient of (10:02 v/v ethy) acctate; makene) to give 1.0 g of 1C as a clear colorless oil. MS (Cl, NH<sub>3</sub>) 362 (MH<sup>±</sup>).

10 D. <u>3a-(R,S)-(4-Fluoro-benzyl)-2-methyl-2.3a,4.5.6.7-hexahydro-pyrazolo[4.3-clpvridin-3-one trifluoroacetate</u>

To 1.00 g (2.8 mmol) of **1C** was added 10 mL of trifluoroacetic acid at about 0 <sup>o</sup>C and the mixture was stirred for about 1 h. Ethyl acetate was added and the mixture was concentrated to give 1.0 g of **1D**. MS (CI, NH<sub>3</sub>) 263 (MH<sup>+</sup>).

15 E. <u>(R)-3-Benzyloxy-2-(2-tert-butoxycarbonylamino-2-methyl-propionylamino)-</u>
propionic acid

To 1.83 g (6.2 mmol) of N-t-BOC-O-benzyl-D-serine in 35 mL of DMF was added 1.02g (7.4 mmol) of potassium carbonate followed by 0.92g (6.5 mmol) of The mixture was stirred overnight at about 24 °C under an atmosphere of nitrogen. The reaction mixture was diluted with 200 mL of water, and extracted three times with ethyl acetate. The combined organics were washed five times with water and once with brine, dried over MgSO4 and concentrated. The crude (R)-3-benzyloxy-2-tert-butoxycarbonyl-amino-propionic acid methyl ester was dissolved in 15 mL of cold trifluoroacetic acid at about 0 °C and the mixture was stirred for about 2 h. The mixture was concentrated and the residue was diluted with 1N NaOH and extracted three times with ethyl acetate. The combined organic extracts were washed with brine and dried over Na<sub>2</sub>SO<sub>4</sub> to give 0.84 g (4.02 mmol) of the resulting (R)-2-amino-3-benzyloxy-propionic acid methyl ester which was coupled to 0.81 g (4.02 mmol) of N-t-BOC-α-methylalanine to give 1.80 g of (R)-3benzyloxy-2-(2-tert-butoxycarbonylamino-2-methyl-propionylamino)-propionic methyl ester. The crude product was dissolved in 20 mL of 4:1 THF:water and a solution of 335 mg (7.98 mmol) of lithium hydroxide hydrat in 1 mL of water was

added to the solution and the mixture was stirred overnight at room temperature. The mixture was concentrated and the residue was diluted with attributed and the node of the control of t

(353) 233 mm2/0 1.30 (m, 5h), 1.13 (α, 11), 3.31 (μ0, 11), 1.13 (m, 11), 1.30 (q), 2π) 4.00 (m, 11), 3.03 (m, 1π), 1.3-1.3 (m, 10π).

- F. (1-(1(R)-Benzyloxymethyl-2-[3a-(R.S)-(4-fluoro-benzyl)-2-methyl-3-oxo-2.3.3a.4.6.7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl]-2-oxo-ethylcarbamoyl}-1-methyl-10 ethyl)-carbamic acid tert-butyl ester
  - According to the method outlined in General Procedure A, 193 mg (0.51 mmol) of 1D and 196 mg (0.51 mmol) of 1E were coupled to give a mixture of diastereomers. The residue was purified by silica gel chromatography using an elution gradient of (1:1 v/v ethyl acetate:hexane) to 100% ethyl acetate to give 60 mg of less polar 1F isomer 1 and 100 mg of more polar 1F isomer 2. MS (CI, NH<sub>3</sub>) 624 (MH<sup>+</sup>) for both isomers.
  - G. 2-Amino-N-{1(R)-benzyloxymethyl-2-[3a-(R)-(4-fluoro-benzyl)-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-2-oxo-ethyl}-isobutyramide hydrochloride
- To 60 mg (0.10 mmol) of 1F isomer 1 in 10 mL of ethanol was added 4 mL of concentrated HCl and the mixture was stirred at room temperature for about 2 h. The mixture was concentrated and the residue was precipitated from ethanol/hexane to give 50 mg of 1G isomer 1 as a white powder. MS (CI, NH<sub>3</sub>) 524 (MH<sup>+</sup>). <sup>1</sup>HNMR (CD<sub>3</sub>OD): (partial) δ 7.32 (m, 5 H), 7.12 (m, 2 H), 6.91 (m, 2 H), 5.15 (m, 1 H), 4.54
  (s, 2 H), 3.78 (m, 2 H)3.02 (m, 7 H), 2.66 (m, 2 H), 1.57 (s, 6 H).
  - H. 2-Amino-N-(1(R)-benzyloxymethyl-2-[3a-(S)-(4-fluoro-benzyl)-2-methyl-3-oxo-2.3.3a.4.6.7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl]-2-oxo-ethyl-isobutyramide hydrochloride
- To 100 mg (0.16 mmol) of **1F isomer 2** in 10 mL of ethanol was added 4 mL of concentrated HCl and the mixture was stirred at room temperature for about 2 h. The mixture was concentrated and the residue was precipitated from ethanol/hexane

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(CD3OD): (partial)  $\delta$  7.32 (m, 5 H), 7.08 (m, 2 H), 6.95 (m, 2 H), 6.80 (m, 2 H), 5.50 (m, 1 H), 4.61 (m, 3 H), 3.80 (m, 2 H), 2.53 (m, 5 H), 1.55 (s, 6 H).

#### Example 2

## A. (R)-2-Amino-3-[(1H-indol-3-yl)-propionic acid methyl ester

To 4.92 g (16.2 mmol) of N-α-t-BOC-D-tryptophan in 100mL of DMF was added 2.46 g (17.8 mmol) of potassium carbonate followed by 2.41 g (17.0 mmol) of iodomethane, and the mixture was stirred overnight at 24°C under an atmosphere of nitrogen. The reaction mixture was diluted with water, and extracted three times with ethyl acetate. The combined organics were washed five times with 500 mL of water and once with brine, dried over MgSO4 and concentrated to give 4.67 g of a white solid. To the crude (R)-2-tert-butoxycarbonylamino-3-(1H-indol-3-yl)-propionic acid methyl ester was added 15 mL of cold trifluoroacetic acid at about 0 °C and the mixture was stirred for about 2 h. The mixture was concentrated and the residue was diluted with 1N NaOH and extracted three times with ethyl acetate. The combined organic extracts were washed with brine and dried over Na<sub>2</sub>SO<sub>4</sub> to give (R)-2-amino-3-(1H-indol-3-yl)-propionic acid methyl ester as an orange oil in quantitative yield.

B. (R)-2-(2-tert-Butoxycarbonylamino-2-methyl-propionylamino)-3-(1H-indol-3-yl)-propionic acid methyl ester.

The crude product from 2A 1.55 g (7.1 mmol) was coupled to 1.44 g (7.1 mmol) of N-t-BOC-α-methylalanine according to Procedure A to give an oil which was purified by silica gel chromatography using a gradient of 10%, 20%, 30%, 40% and 50% ethyl acetate in hexane to elute. Recovered 1.32 g of (R)-2-(2-tert-butoxycarbonylamino-2-methyl-propionylamino)-3-(1H-indol-3-yl)-propionic acid methyl ester.

- C. (R)-2-(2-tert-Butoxycarbonyla<u>mino-2-methyl-propionylamino)-3-(1H-indol 3-yl) przysi wie z się</u>
- austrial to plick with direct about 100,000 and 100,00

with ethyl acetate and the combined organic extracts were washed with brine, dried over MgSO4 and evaporated to give 1.03 g of 2C as an orange foam. MS (CI, NH<sub>3</sub>)

- 390 (MH<sup>+</sup>). <sup>1</sup>H NMR (CDCl<sub>3</sub> 300 MHz) δ 7.61 (d, 1H), 7.48 (d, 1H), 7.27 (t, 1H), 7.10 (t, 1H), 4.81 (bs, 1H), 3.35 (m, 1H), 1.49 (s, 6H), 1.32 (s, 9H).
  - D. {1-[2-[3a-(R.S)-(4-Fluoro-benzyl)-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethylcarbamoyl]-1-methyl-ethyl)-carbamic acid tert-butyl ester
- According to the method outlined in General Procedure A, 193 mg (0.51 mmol) of 1D and 200 mg (0.51 mmol) of 2C were coupled and the residue was purified by silica gel chromatography using an elution gradient of (1:1 v/v ethyl acetate:hexane) to 100% ethyl acetate to give 230 mg of 2D. MS (Cl, NH<sub>3</sub>) 633 (MH<sup>+</sup>).
- E. 2-Amino-N-[2-[3a-(R.S)-(4-fluoro-benzyl)-2-methyl-3-oxo-2.3.3a,4.6,720 hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-1(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyl]isobutyramide hydrochloride

To 230 mg (0.36 mmol) of **2D** in 10 mL of ethanol was added 4 mL of concentrated HCl and the mixture was stirred at room temperature for about 2 h. The mixture was concentrated and the residue was precipitated from ethanol/hexane to give 130 mg of **2E** as a white powder. MS (CI, NH<sub>3</sub>) 533 (MH<sup>+</sup>). <sup>1</sup>HNMR (CD<sub>3</sub>OD): (partial)  $\delta$  7.79 (d, 1 H), 7.48 (m, 1 H), 7.33 (m, 2 H), 7.19 - 6.77 (m, 7 H), 6.54 (m, 1 H), 5.17 (m, 1 H), 4.02 (m, 1 H), 3.11 - 2.68 (m, 6 H), 2.47 (m, 2 H), 2.03 (m, 2 H), 1.59 (m, 6 H).

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#### Example ?

2-Aminu-11 [2-(15 (7.3)-benzyl-2 1 1 ) 1 2 2 2 3 3 7 hazale 1 2 3 7 15 11 2

a mixture 2 grows added a solution of 7,00 grows 17 b. The mixture butyldicarbonate in 150 mL of methylene chloride over about 30 min. The mixture

was warmed to room temperature and then stirred for about 17 h. The mixture was concentrated and the residue was diluted with chloroform and washed three times each with 10% aqueous HCl, saturated aqueous sodium bicarbonate solution and

B. 3-(R.S)-Benzyl-4-oxo-piperidine-1.3-dicarboxylic acid 1-tert-butyl ester 3-methyl ester

brine, dried over MgSO4 and concentrated to give 9.18 g of a clear yellow oil.

To a solution of 5.00 g (19.4 mmol) 3A in 10 mL of DMF was added 745 mg (7.4 mmol) of sodium hydride (60% oil dispersion) and the mixture was stirred at room temperature for about 15 min. A solution of 3.32 g (19.4 mmol) benzylbromide in 15 mL of DMF was added to the stirring solution by cannula and the mixture was stirred for about 42 h at room temperature. The mixture was diluted with ethyl acetate and washed once with water and four times with brine, dried over MgSO<sub>4</sub>, and concentrated to give 6.0 g of 3B as a yellow oil. MS (CI, NH<sub>3</sub>) 348 (MH<sup>+</sup>).

C. <u>3a-(R,S)-Benzyl-2-methyl-3-oxo-2,3,3a,4.6.7-hexahydro-pyrazolo[4.3-c]-pyridine-5-carboxylic acid tert-butyl ester</u>

A mixture of 4.00 g (11.5 mmol) of 3B and 530 mg (11.5 mmol) of methylhydrazine in 100 mL of ethanol was heated at reflux for about 8 h. The mixture was concentrated and the residue was dissolved in 100 mL toluene and heated at reflux for about 17 h. The mixture was concentrated and the residue was purified by silica gel chromatography using an elution gradient of (15:85 v/v ethyl acetate:hexane) to (75:25 v/v ethyl acetate:hexane) to give 2.6 g of 3C as a clear colorless oil. MS (CI, NH<sub>3</sub>) 344 (MH<sup>+</sup>).

D. 3a-(R,S)-Benzvl-2-methyl-2,3a,4,5,6 7-hexahydro-nyrazolof4 3-clhyridin-3-one

at 2.5 h. The state of h at h

- c]pyridin-5-yl)-1R-(1H-indol-3-ylmethyl)-2-oxo-ethylcarbamoyl]-1-methyl-ethyl}carbamic acid text putyl ester
- According to the method outlined in General Procedure A, 125 mg (4.6 mmol) of 3C and 1.75 g (0.51 mmol) of 2C were coupled and the residue was purified by silica gel chromatography using an elution gradient of (6:4 v/v ethyl acetate:hexane) to 7% methanol in ethyl acetate to give 150 mg of 3E.
- F. 2-Amino-N-[2-(3a-(R.S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1R-(1H-indol-3-ylmethyl)-2-oxo-ethyl]-isobutyramide hydrochloride
  - To 150 mg (0.24 mmol) of **3E** in 15 mL of ethanol was added 5 mL of concentrated HCl and the mixture was stirred at room temperature for about 3 h. The mixture was concentrated and the residue was crystallized from ethanol/hexane to give 100 mg of
- 3F: MS (CI, NH<sub>3</sub>) 515 (MH<sup>+</sup>). <sup>1</sup>HNMR (CD<sub>3</sub>OD): δ 7.20 6.91 (m, 9 H), 6.56 (m, 1), 5.17 (m, 1 H), 4.05 (m, 1 H), 2.96 (s, 3 H), 2.62 (m, 1 H), 2.38 (m, 1 H), 2.06 (m, 2 H), 1.61 (m, 8 H).

#### Example 4

- 2-Amino-N-[2-(3a-(R)-benzyl-2-methyl-3-oxo-2.3.3a.4.6.7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide hydrochloride and 2-Amino-N-[2-(3a-(S)-benzyl-2-methyl-3-oxo-2.3.3a.4.6.7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide hydrochloride
  - A. {1-[2-(3a-(R,S)-Benzyl-2-methyl-3-oxo-2.3.3a.4.6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethylcarbamoyl]-1-methyl-ethyl}-
- 30 <u>carbamic acid tert-butyl ester</u>

According to the method outlined in General Procedure A, 1.12 g (4.6 mmol) of 3C and 1.75 g (0.51 mmol) of 1E were coupled to give a mixture of diastereomers. The

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v/v ethyl acetate:hexane) to 100% ethyl acetate to give 350 mg of thesis  $r^{-1} = 4\Lambda$ 

b. 2-Amino-N-12-(pa-th), which would be a superficient of the first of the month of the month of the first of the month of the first of the month of the first of the month of

To 250 mg (0.41 mmol) of 4A isomer 1 in 15 mL of ethanol was added 5 mL of concentrated HCl and the mixture was stirred at room temperature for about 5 in. The mixture was concentrated and the residue was precipitated from ethanol/hexane and dried under vacuum to give 130 mg of 4B isomer 1. MS (CI, NH<sub>3</sub>) 506 (MH<sup>+</sup>). 1HNMR (CD<sub>3</sub>OD): δ 7.33 (m, 5 H), 7.14 (m, 5 H), 5.22 (m, 1 H), 4.57 (m, 3 H), 3.80 (m, 2 H) 3.14 (m, 1 H), 3.04 (s, 3 H), 2.96 (m, 2 H), 2.61 (m, 2 H), 1.63 (m, 7 H).

C. <u>2-Amino-N-[2-(3a-(S)-benzyl-2-methyl-3-oxo-2,3,3a,4.6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide hydrochloride</u>

To 250 mg (0.41 mmol) of **4A isomer 2** in 15 mL of ethanol was added 5 mL of concentrated HCl and the mixture was stirred at room temperature for about 5 h. The mixture was concentrated and the residue was precipitated from ethanol/hexane and dried under vacuum to give 120 mg of **4C isomer 2**. MS (CI, NH<sub>3</sub>) 506 (MH<sup>+</sup>). <sup>1</sup>HNMR (CD<sub>3</sub>OD): δ 7.31 (m, 5 H), 7.13 (m, 5 H), 6.78 (m, 1 H), 5.28 (m, 1 H), 4.62 (m, 3 H), 3.81 (M, 2 H), 3.14 (m, 1 H), 2.62 (m, 3 H), 1.58 (m, 7 H).

D. 2-Amino-N-[2-(3a-(R)-benzyl-2-methyl-3-oxo-2.3.3a.4.6.7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide methanesulfonate

Saturated aqueous sodium bicarbonate was added to 3.60 g (6.6 mmol) of 4B isomer 1 and the mixture was extracted with ethyl acetate. The organic layer was dried over MgSO<sub>4</sub> and concentrated. The residue was dissolved in ethyl acetate, cooled to about 0 °C and 0.43 mL (6.6 mmol) of methane-sulfonic acid was added and the mixture was stirred for about 0.5 h. Hexane (200 mL) was added to the solution and the mixture was stirred for about 1h and filtered to give 3.40 g of a whit

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solid. The solid was recrystallized from 3% aqueous ethyl acetate to give 2.55 g of 4D increased as a white crystalline solid. MS (CI, NH<sub>3</sub>) 506 (MH<sup>+</sup>)

2-Amino-iv-[1-(3a-(rx)-benzyl-2-me(hyl-3-0x0-2/3,3a,4,0,7-nexal,xc 3-7,12-3-7,4-3-

2-Amino-N-I1-(32-(\$)-henzul-2 modifield out 3.3.20.1.2.7 heard publication 1.3.5.5 c)pyridina-5-carbonyl)-4-phenyl-(R)-butyl) isotophyr airla hydrochlorid.

A. 2-Oxo-5,6-diphenyl-3-(3-phenyl-allyl)-morpholine-4-carboxylic acid t-butyl ester

To an about -78°C solution of 13.8 g (70.0 mmol) of cinnamyl bromide and 4.94 g (14.0 mmol) of t-butyl-(2S,3R)-(+)-6-oxo-2,3-diphenyl-4-morpholine carboxylate in 350 mL of anhydrous THF was added 28 mL (28 mmol) of 1M sodium bistrimethylsilylamide in THF. The mixture was stirred at about -78°C for about 1.5 h and then poured into 750 mL of ethyl acetate. The mixture was washed twice with brine, dried over MgSO4 and concentrated to give a yellow oil. The oil was stirred in 150 mL of hexane overnight and the precipitated solid was then collected by filtration to give 3.2 g of 5A as a white solid.

#### B. <u>5(S).6(R)-Diphenyl-3(R)-(3-phenyl-allyl)-morpholin-2-one</u>

To 2.97 g (6.33 mmol) of **5A** was added 20 mL of trifluoroacetic acid at about 0°C and the mixture was stirred for about 2 h and then concentrated. The residue was dissolved in water and basified with aqueous NaOH until a pH of 10 was maintained. The mixture was extracted three times with ethyl acetate and the combined organic extracts were washed with brine, dried over MgSO<sub>4</sub> and concentrated to give an orange oil which was purified by silica gel chromatography (10:90 v/v ethyl acetate:hexane) to give 880 mg of 5B as a white solid.

## C. 2-(R)-Amino-5-phenyl-pentanoic acid

A mixture of 440 mg (1.19 mmol) of 5B and 120 mg of palladium chloride in 20 mL of ethanol and 10 mL of THF was hydrogenated at 45 psi. for about 16 h. The mixture was filtered through diatomaceous earth and concentrated, and the residue was triturated with ether to give 240 mg of 5C as a white solid.

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concentrated. The product was purified by silica got chromatography (1:1 v/v - try) acetatatha canes) to give 5.2 g of the title compound of this part D as a white solid

- 10 E. <u>(R)-2-(2-tert-Butoxycarbonylamino-2-methyl-propionylamino)-5-phenyl-pentanoic acid</u>
  - A mixture of 203 mg (1.05 mmol) of 5D, 378 mg (1.26 mmol) of 5C and 434 mg (3.36 mmol) of diisopropylethylamine in 2 mL of DMF was stirred over-night. The mixture was diluted with ethyl acetate and extracted twice with 1N HCl. The aqueous phase was extracted once with ethyl acetate. The pooled organic extracts were washed three times with water and once with brine. The mixture was dried over MgSO4 and concentrated. The residue was purified by silica gel chromatography using 80% chloroform in hexane followed by 100% chloroform followed by 10% methanol in chloroform to give 127 mg of 5E.
- F. {1-[1-(3a-(R,S)-Benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridine-5-carbonyl)-4-phenyl-(R)-butylcarbamoyl]-1-methyl-ethyl}-carbamic acid tert-butyl ester

  According to the method outlined in General Procedure A, 130 mg (0.53 mmol) of 3C
  - and 200 mg (0.53 mmol) of 5E were coupled to give a mixture of diastereomers. The residue was purified by silica gel chromatography using an elution gradient of (1:1 v/v ethyl acetate:hexane) to 100% ethyl acetate to give 40 mg of less polar 5F isomer 1 and 40 mg of more polar 5F isomer 2. MS (CI, NH<sub>3</sub>) 604 (MH<sup>+</sup>) for both isomers.
- G. 2-Amino-N-[1-(3a-(R)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridine-5-carbonyl)-4-phenyl-(R)-butyl]-isobutyramide hydrochloride

  To 40 mg (0.07 mmol) of 5F isomer 1 in 10 mL of ethanol was added 4 mL of concentrated HCl and the mixture was stirred at room temperature for about 4 h.

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The mixture was concentrated and the residue was precipitated from methylane chloride/hexane and dried under vacuum to give 30 mg of 5G isomer 1. MS (CI,

(m, 6 m), 2.67 (m, 4 H), 1.83 (m, 4 m), 1.52 (s, 6 H), 1.28 (m, 1 H).

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concentrator! HCI and the mixture was stirred at room temperature for about 4 h. The mixture was concentrated and the residue was precipitated from mathylane chloride/hexane and dried under vacuum to give 30 mg of 5H isomer 2. MS (CI, NH3) 504 (MH+). <sup>1</sup>HNMR (CD3OD): (partial) 7.25 (m, 9 H), 6.88 (m, 1 H), 3.04 (s, 3 H), 2,71 (m, 4 H), 2.48 (m, 2 H), 1.75 (m, 4 H), 1.62 (m, 6 H), 1.28 (m, 1 H).

#### Example 6

2-Amino-N-[2-(3a-(R,S)-benzyl-2-methyl-3-oxo-2,3.3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide hydrochloride

A. <u>{1-[2-(3a-(R.S)-Benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethylcarbamoyl]-1-methyl-ethyl}-carbamic acid tert-butyl ester</u>

According to the method outlined in General Procedure A, 200 mg (0.82 mmol) of 3C and 320 mg (0.82 mmol) of 1E were coupled to give a mixture of diastereomers. The residue was purified by silica gel chromatography using an elution gradient of (1:1 v/v ethyl acetate:hexane) to 10% methanol in ethyl acetate to give 170 mg of 6A.

- B. 2-Amino-N-[2-(3a-(R,S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide hydrochloride
  - To 170 mg (0.28 mmol) of **6A** in 20 mL of ethanol was added 5 mL of concentrated HCl and the mixture was stirred at room temperature for about 2.5 h. The mixture was concentrated and the residue was precipitated from ethanol/hexane to give 70 mg of **6B**. MS (CI, NH<sub>3</sub>) 506 (MH<sup>+</sup>). <sup>1</sup>HNMR (CD<sub>3</sub>OD): δ 7.32 (m, 5 H); 7.16 (m, 5 H), 5.22 (m, 1 H), 4.67 (m,1 H), 4.55 (m, 2 H), 3.79 m, 2 H), 3.12 (m, 2 H), 3.00 (m, 6 H), 2.71 (m, 3 H), 1.56 (m, 8 H).

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## Txampin 7

# 2-Amino-N-[2-(3a-benzyl-2-ethyl-3-oxo-2.3,3a,4.6,7-hexahydro-pyrazulo[4,3-

A. Satisfy the design of the state of the st

mixture was concentrated and the residue was purified by silica get chromatography using an elution gradient of (10:1 v/v hexane:ethyl acetate) to (3:7 v/v hexane:ethyl acetate) to give 357 mg of 7A. MS (CI, NH<sub>3</sub>) 358 (MH<sup>+</sup>).

- B. <u>3a-(R,S)-Benzyl-2-ethyl-2,3a,4,5,6,7-hexahydro-pyrazolo[4,3-c]pyridin-3-one</u> To 350 mg (0.98 mmol) of **7A** in 3 mL of ethanol was added 1.5 mL of concentrated HCl and the mixture was stirred at room temperature for about 2 h. The mixture was concentrated to give 257 mg of **7B**. MS (CI, NH<sub>3</sub>) 258 (MH<sup>+</sup>).
- 15 C. <u>{1-[2-(3a-(R,S)-Benzyl-2-ethyl-3-oxo-2.3,3a.4.6.7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl)-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethylcarbamoyl]-1-methyl-ethyl}-carbamic acid tert-butyl ester</u>

According to the method outlined in General Procedure A, 82 mg (0.28 mmol) of 7B and 100 mg (0.26 mmol) of 2C were coupled and the residue was purified by silica gel chromatography using an elution gradient of 100% methylene chloride to 2% methanol in methylene chloride to give 110 mg of 7C. MS (CI, NH<sub>3</sub>) 629 (MH<sup>+</sup>).

- D. 2-Amino-N-[2-(3a-(R.S)-benzyl-2-ethyl-3-oxo-2.3,3a,4.6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyl]-isobutyramide hydrochloride
- To 100 mg (0.15 mmol) of **7C** in 2 mL of ethanol was added 1 mL of concentrated HCl and the mixture was stirred at room temperature for about 2 h. The mixture was concentrated to give 72 mg of **7D** as a colorless foam. MS (CI, NH<sub>3</sub>) 529 (MH<sup>+</sup>).

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#### Example 8

- 3. Amino-N-[2-(3a-(R)-benzyl-2 at 1.2 oxo-2.3.3a.4.6.7-howard a surranolo[4.3-
- (1) (1) (He Richard 1-(R))-<u>berty/hop</u> (1) (He Richard 1) (He Richar
- According to the method outlined in General Procedure A, 85 mg (0.29 mmol) of 7B and 100 mg (0.26 mmol) of 1E were coupled to give a mixture of diastereomers. The residue was purified by silica gel chromatography using an elution gradient of 100% methylene chloride to 2% methanol in methylene chloride to give 6 mg of less polar 8A isomer 1 and 11 mg of more polar 8A isomer 2. MS (CI, NH<sub>3</sub>) 620 (MH<sup>+</sup>) for both isomers.
- 15 B. <u>2-Amino-N-[2-(3a-(R)-benzyl-2-ethyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide hydrochloride</u>
  - To 5.7 mg (0.009 mmol) of **8A** isomer 1 in 1 mL of ethanol was added 0.4 mL of concentrated HCl and the mixture was stirred at room temperature for about 3 h. The mixture was concentrated to give 4.7 mg of **8B** isomer **1**. MS (CI, NH<sub>3</sub>) 520 (MH<sup>+</sup>).  $^{1}$ HNMR (CD<sub>3</sub>OD): (partial)  $\delta$  7.41 7.05 (m, 10 H), 5.20 (m, 1 H), 4.61 (m, 1H), 4.52 (s, 2 H), 3.71 (m, 1 H), 3.60 (m, 1 H), 2.61 (m, 3 H), 1.39 (m, 9 H).
  - C. 2-Amino-N-[2-(3a-(\$)-benzyl-2-ethyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide
- 25 <u>hydrochloride</u>

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To 10 mg (0.016 mmol) of **8A isomer 2** in 1 mL of ethanol was added 0.4 mL of concentrated HCl and the mixture was stirred at room temperature for about 3 h. The mixture was concentrated to give 8 mg of **8C isomer 2**. MS (CI, NH<sub>3</sub>) 520 (MH<sup>+</sup>).  $^{1}$ HNMR (CD<sub>3</sub>OD): (partial)  $\delta$  7.43 - 7.00 (m, 10 H), 6.81 (m, 1 H), 5.32 (m, 1 H), 4.63 (m, 2 H), 4.53 (m, 1 H), 3.72 (m, 1 H), 1.37 (m, 9 H).

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#### Example 9

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Confidence of and made of (2) contains an about the first of the

ethanol was heated at reflux for about 17 h. The mixture was concentrated and the residue was dissolved in 100 mL of toluene and heated at reflux for about 48 h. The mixture was diluted with ethyl acetate and washed with brine, dried over MgSO<sub>4</sub> and concentrated and the residue was purified by silica gel chromatography using 100% ethyl acetate followed by 5% methanol in methylene chloride to give 530 mg of 9A as a light brown solid. MS (C1, NH<sub>3</sub>) 330 (MH<sup>+</sup>).

- B. 2-Benzyl-4.5.6.7-tetrahydro-2H-pyrazolo[4.3-c]pyridin-3-ol
- To 411 mg (1.24 mmol) of **3E** in 30 mL of ethanol was added 10 mL of concentrated HCl and the mixture was stirred at room temperature for about 30 min. The mixture was concentrated and the residue was crystallized from methanol/ethyl acetate to give 353 mg of **9B**. MS (CI, NH<sub>3</sub>) 230 (MH<sup>+</sup>).
- C. {1-[2-(2-Benzyl-3-hydroxy-2,4,6,7-tetrahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-R-benzyloxymethyl-2-oxo-ethylcarbamoyl]-1-methyl-ethyl}-carbamic acid tert-butylester

According to the method outlined in General Procedure A, 100 mg (0.38 mmol) of 9B and 145 mg (0.38 mmol) of 1E were coupled and the residue was purified by silica gel chromatography (95:5 v/v methanol:methylene chloride) to give 42 mg of 9C as a white solid. MS (CI, NH<sub>3</sub>) 592 (MH<sup>+</sup>).

D: 2-Amino-N-[2-(2-benzyl-3-oxo-2,3.3a,4,6.7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide hydrochloride

To 42 mg (0.07 mmol) of **9D** in 20 mL of ethanol was added 6 mL of concentrated HCl and the mixture was stirred at room temperature for about 30 min. The mixture was diluted with ethanol concentrated and the residue was precipitated from methanol/ethyl acetate to give 35 mg of **9D** as a white solid. MS (CI, NH<sub>3</sub>) 492

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(MH+). <sup>1</sup>HNMR (CD<sub>3</sub>OD): (partial) 7.41 - 7.16 (m, 10 H), 5.19 (m, 3 H), 4.12 (m, 4 m), 3.88 (m, 1 H), 3.74 (m, 2 m), 2.88 (m, 2 H), 3.88 (m, 1 H).

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2-Amino-N-(2-(3a-(R)-benzyl-3-oxo-2-(2,2,2-triffuoro-athyl) 3 3,3a 4 6 7-beyohydro-

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pyrazoloj4.3-c]pyridin-5-yl]-1-(R)-besikalozymena a zastania bydrochloride

A. <u>3a-(R,S)-Benzyl-3-oxo-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridine-5-carboxylic acid tert-butyl ester</u>

A mixture of 840 mg (2.42 mmol) of 3B and 276 mg (2.42 mmol) of 2,2,2-trifluoroethylhydrazine (70% in water) in 20 mL of ethanol was heated at reflux for about 5 h and then concentrated. The residue was dissolved in 40 mL of toluene and heated at reflux for about 17 h. The mixture was concentrated and the residue was purified by silica gel chromatography (9:1 v/v hexane:ethyl acetate) to give 703 mg of 10A as a yellow oil. MS (CI, NH<sub>3</sub>) 412 (MH<sup>+</sup>).

- B. <u>3a-(R,S)-Benzyl-2-(2,2,2-trifluoro-ethyl)-2,3a,4,5,6,7-hexahydro-pyrazoloj4,3-</u>c)pyridin-3-one
- To 600 mg (1.46 mmol) of **10A** at about 0 °C was added 3 mL of cold trifluoroacetic acid and the mixture was stirred for about 3 h, allowing the solution to reach room temperature as it did so. The mixture was concentrated and the residue was dissolved in water and the solution was basified to pH 11 with 5N NaOH and then saturated with potassium carbonate. The solution was extracted three times with ethyl acetate and the combined organic extracts were washed with brine, dried over MgSO4 and concentrated to give 345 mg of 10B as an opaque oil. MS (CI, NH<sub>3</sub>) 312 (MH<sup>+</sup>).
  - C. (1-(2-[3a-(R,S)-Benzyl-3-oxo-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-1-(R)-benzyloxymethyl-2-oxo-ethylcarbamoyl)-1-methyl-ethyl)-carbamic acid tert-butyl ester

According to the method outlin d in General Procedure A, 137 mg (0.44 mmol) of 10B and 167 mg (0.44 mmol) of 1E were coupled to give a mixture of diastereomers.

The residue was purified by silical get phromatography using an elution gradient 100% methylene chloride to 5% methanol in methylene chloride to give 120 mg of large polar 100 (apmer 1 and 00 mg of large polar 100 (apmer 2 MG (01, 1115) 07 (MH<sup>+</sup>) for both isomers

- begins a sequence of the seque
- To 120 mg (0.18 mmol) of 10C isomer 1 in 3.5 mL of ethanol was added 1.5 mL of concentrated HCl and the mixture was stirred at room temperature for about 2 h.

  The mixture was concentrated to give 94 mg of 10D isomer 1 as an off-white powder. MS (CI, NH<sub>3</sub>) 574 (MH<sup>+</sup>). <sup>1</sup>HNMR (CD<sub>3</sub>OD): (partial) δ 7.31 (m, 5 H), 7.18 (m, 5 H), 5.21 (m, 1 H), 4.57 (m, 3 H), 4.26 (m, 1 H), 4.08 (m, 1 H), 3.79 (m, 2 H), 3.09 (m, 4 H), 2.65 (m, 2 H), 1.63 (m, 6 H).
- E. 2-Amino-N-{2-[3a-(S)-benzyl-3-oxo-2-(2.2.2-trifluoro-ethyl)-2.3.3a.4.6.7
  hexahydro-pyrazolo[4.3-c]pyridin-5-yl]-1-(R)-benzyloxymethyl-2-oxo-ethyl)isobutyramide hydrochloride

To 53 mg (0.079 mmol) of 10C isomer 2 in 3.5 mL of ethanol was added 1.5 mL of concentrated HCl and the mixture was stirred at room temperature for about 2 h. The mixture was concentrated to give 41 mg of 10E isomer 2 as a light yellow solid.

MS (CI, NH<sub>3</sub>) 574 (MH<sup>+</sup>). <sup>1</sup>HNMR (CD<sub>3</sub>OD): (partial) δ 7.33 (m, 5 H), 7.15 (m, 4 H), 6.81 (m, 1 H), 5.30 (m, 1 H), 4.67 (m, 4 H), 4.15 (m, 2 H), 3.77 (m, 2 H), 3.09 (m, 3 H), 2.64 (m, 3 H), 1.58 (m, 6 H).

#### Example 11

- 2-Amino-N-[2-(3a-(R)-benzyl-2-tert-butyl-3-oxo-2.3,3a,4.6,7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide methanesulfonate and
  - 2-Amino-N-[2-(3a-(S)-benzyl-2-tert-butyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide methanesulfonate
- A. <u>3a-(R.S)-Benzyl-2-tert-butyl-3-oxo-2.3.3a,4.6.7-hexahydro-pyrazolo[4.3-</u>
  30 <u>clpyridine-5-carboxylic acid tert-butyl ester</u>
  - To 2.07 g (5.95 mmol) of 14B in 40 mL of ethanol was added 0.97 g (7.7 mmol) of tert-butylhydrazine hydrochloride and 0.63 g (7.7 mmol) of sodium acetate and the

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mixture was boated at about 70 90 for about 47 h. The mixture was cooled and the solution decented from the precipitate and concentrated. The residue was discussed in 90 mls of takens and heated at reflex for about 6 h. The mixture was concentrated and the residue was purified by silica gel chromatography (0:1 v/v

VIE 130

To 535 mg (1.39 mmol) of 11A in 16 mL of methyrene chloride was acced 125  $\mu$ L or methanesulfonic acid and the mixture was stirred for about 1.5 h at room temperature. The mixture was diluted with ethyl acetate and washed twice with 1N NaOH and once with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated to give 245 mg of 11B. MS (CI, NH<sub>3</sub>) 286 (MH<sup>+</sup>).

- C. <u>{1-[2-(3a-(R,S)-Benzyl-2-tert-butyl-3-oxo-2,3,3a,4.6,7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethylcarbamoyl]-1-methyl-ethyl}-carbamic acid tert-butyl ester</u>
- According to the method outlined in General Procedure A, 246 mg (0.86 mmol) of 11B and 328 mg of 14F were coupled to give a mixture of diastereomers. The residue was purified by silica gel chromatography (6:4 v/v hexane/ethyl acetate) to give 250 mg of less polar 11C isomer 1 and 90 mg more polar 11C isomer 2. MS (CI, NH<sub>3</sub>) 648 (MH<sup>+</sup>) for both isomers.
- D. <u>2-Amino-N-[2-(3a-(R)-benzyl-2-tert-butyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide methanesulfonate</u>
- To 210 mg (0.32 mmol) of 11C isomer 1 in 15 mL of methylene chloride at about 0 °C was added 28 μL (0.44 mmol) of methanesulfonic acid. The ice bath was removed and the mixture was stirred for about 3 h, diluted with 15 mL of diethyl ether and the precipitated solid was collected by filtration to give 100 mg of 11D isomer 1. MS (CI, NH<sub>3</sub>) 548 (MH<sup>+</sup>). <sup>1</sup>H NMR (CD<sub>3</sub>OD): (partial) δ 7.33 (m, 5 H), 7.27 7.07 (m, 5 H), 5.21 (m, 1 H), 4.54 (m, 3 H), 3.86 (m, 3 H), 3.10 (m, 4 H), 2.61 (s, 3 H), 1.62 (m, 6 H), 1.18 (s, 9 H).

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E. 2-Amino-N-[2-(3a-(\$)-ben-yl-2-to-t-butyl-3-oxo-2-3-3-4-0-7-beyobudropyrazoroja, o-cipyridin-o-yli-1-(ki)-ben-yl-2-to-t-butyl-3-oxo-2-3-3-4-0-7-beyobudromethano-yli-1-

To 85 mg (0.13 mmol) of 11C isomer 2 in 10 mL of methyland chloride at about 0

MS (CI, NH<sub>3</sub>) 548 (MH<sup>+</sup>). <sup>1</sup>H NMR (CD<sub>3</sub>OD): (partial)  $\delta$  8.28 (br d, 1 H), 7.32 (m, 5 H), 7.18 (m, 4 H), 6.84 (m, 1 H), 5.31 (m, 1 H), 4.60 (m, 3 H), 3.70 (m, 3 H), 3.18 - 2.92 (m, 3 H), 2.68 (s, 3 H), 1.57 (m, 6 H), 1.13 (s, 9 H).

## Example 12

2-Amino-N-[1-(R)-(1H-indol-3-ylmethyl)-2-(2-methyl-3-oxo-3a-(R.S)-pyridin-2-ylmethyl-2.3.3a.4.6.7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl)-2-oxo-ethyl]-isobutyramide dihydrochloride

15 A. 4-Oxo-3-(R.S)-pyridin-2-ylmethyl-piperidine-1,3-dicarboxylic acid 1-tert-butyl ester 3-methyl ester

To a solution of 2.00 g (7.8 mmol) of 3A in 32 mL of THF was added 468 mg (11.7 mmol) of sodium hydride (60% oil dispersion) at about 0 °C and the mixture was stirred for about 30 min. A solution of 762 mg (6.0 mmol) 2-picolyl chloride in 5 mL of THF was added to the stirring solution over about 5 min, followed by the addition of 432 mg (2.6 mmol) of potassium iodide. The ice bath was removed and the mixture was heated for about 17 h at reflux. The mixture was diluted with ethyl acetate and washed once with water and once with brine, dried over MgSO4, and concentrated. The residue was purified by silica gel chromatography using (6:4 v/v ether:hexane) followed by (6:4 v/v ethyl acetate:hexane) to give 1.2 g of 12A. MS (CI, NH3) 349 (MH<sup>+</sup>).

B. <u>2-Methyl-3-oxo-3a-(R,S)-pyridin-2-ylmethyl-2.3.3a.4.6.7-hexahydro-pyrazolo[4.3-c]pyridine-5-carboxylic acid tert-butyl ester</u>

A mixture of 1.20 g (3.45 mmol) of 12A and 159 mg (3.45 mmol) of methylhydrazine in 20 mL of ethanol was heated at reflux for about 6.5 h. The mixture was concentrated and the residue was dissolved in 25 mL toluene and h ated at reflux for about 17 h. The mixture was concentrated and th residue was purified by silica

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del chromatography (65:35 v/v ethyl acetate:bevane) to dive 450 mg of 12R MS (Ci, 1413) 345 (MH+).

2.14(4):1.20.(2.5) pyridin-3-ylmot(5):3.3 (1.5.0.2 heyebyden nym (1.11.3 Cipyriam-3-one unitydrochlonde

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{1-I1-(1-(R)-H-Indol-3-vimethyl)-2-(2-methyl-3-oxo-3a-(R,S)-pyridin-2-D. <u>vlmethyl-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-clpyridin-5-yl)-2-oxo-ethylcarbamoyl]-</u> 1-methyl-ethyl}-carbamic acid tert-butyl ester

According to General Procedure A, 108 mg (0.31 mmol) of 12C and 122 mg (0.31 mmol) of 2C were coupled and the residue was purified by silica get chromatography (95:5 v/v ethyl acetate:methanol) to give 118 mg of 12D. MS (CI, NH<sub>3</sub>) 616 (MH<sup>+</sup>).

- 2-Amino-N-I1-(R)-(1H-indol-3-ylmethyl)-2-(2-methyl-3-oxo-3a-(R.S)-pyridin-2-15 vlmethyl-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-2-oxo-ethyl]isobutyramide dihydrochloride
  - A mixture of 110 mg (0.18 mmol) of 12D in 1 mL of 4M HCl/dioxane was stirred at room temperature for 17 h. The mixture was concentrated to give 51 mg of 12E. MS (CI, NH<sub>3</sub>) 516 (MH<sup>+</sup>). <sup>1</sup>HNMR (CD<sub>3</sub>OD): (partial)  $\delta$  8.91 - 8.52 (m, 2 H), 8.04 (m,
- 20 2 H), 7.76 - 7.50 (m, 3 H), 6.82 (m, 1 H), 4.62 (m, 1 H), 3.36 (s, 3 H), 1.63 (s, 6 H). Example 13
  - 2-Amino-N-[1-(R)-benzyloxymethyl-2-(2-methyl-3-oxo-3a-(R,S)-pyridin-2-ylmethyl-2.3.3a.4.6.7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl)-2-oxo-ethyl]-isobutyramide dihydrochloride
- 25 A. {1-[1-(R)-Benzyloxymethyl-2-(2-methyl-3-oxo-3a-(R.S)-pyridin-2-ylmethyl-2.3.3a.4.6.7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl)-2-oxo-ethylcarbamoyl]-1-methylethyll-carbamic acid tert-butyl ester

According to General Procedure A, 86 mg (0.27 mmol) of 12C and 103 mg (0.27 mmol) of 1E were coupled and the residue was purified by silica gel chromatography (95:5 v/v ethyl acetate:hexane) to give 82 mg of 13A.

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1.63 (m, 6 H).

#### Example 14

- 2-Amino-N-[2-(3a-(R)-benzyl-2-methyl-3-oxo-2.3.3a,4.6.7-hexahydro-pyrazolo[4.3-clpyridin-5-yl)-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyl]-isobutyramide
  - A. 4-Oxo-piperidine-1.3-dicarboxylic acid 1-tert-butyl ester 3-methyl ester. To a mixture of 100.0 g (516.4 mmol) of 4-oxo-piperidine-3-carboxylic acid methyl ester and 63 g (516.4 mmol) of 4,4-dimethylaminopyridine in 1 L of methylene chloride at about 0 °C was added a solution of 113.0 g (516.4 mmol) of di-tert-butyldicarbonate in 100 mL of methylene chloride over about 90 min. The mixture was slowly warmed to room temperature and then stirred for about 19 h. The mixture was washed three times each with 10% aqueous HCl, saturated aqueous sodium bicarbonate solution and brine, dried over MgSO4 and concentrated to give
- 20 **130.5 g of 14A** as an amorphous solid. <sup>1</sup>HNMR (CDCl<sub>3</sub>): δ 4.03 (br, 2H); 3.74 (s, 3H), 3.56 (t, 2H), **2.36** (t, 2H), 1.42 (s, 9H).
  - B. 3-(R)-Benzyl-4-oxo-piperidine-1.3-dicarboxylic acid 1-tert butyl ester 3-methyl ester

To a stirred suspension of 11.7 g (293 mmol) of sodium hydride (60% oil dispersion washed twice with 100 mL of hexane) in 100 mL of DMF was added a solution of 65.4 g (254 mmol) of 14A in 150 mL of DMF at about 0 °C over about 45 min. The ice bath was removed and the mixture was stirred at room temperature for about 45 min. The mixture was recooled to about 0 °C and 35.2 mL (296 mmol) of benzylbromide in 200 mL of DMF was added dropwise to the stirring solution and the mixture was stirred for about 23 h at room temperature. To the solution was carefully added 550 mL of water and the mixture was stirred for about 30 min. The mixture was extract d three times with ethyl acetate and the combined organic

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extracts were washed five times with water, once with brine, dried over MgSO4 and a contract of to give 00 g of days in a city. The city could be a contract of to give 00 g of days in a city. The city could be a city of the city could be a city of the city o

C. 3a-(R)-Durizyl-2-methyl-3-oxo-2,3 3a 4.6.7-hexabivitro-pythzolof4.3-

A mixture of 47.0 g (135 mmol) of 14B, 38.9 g (270 mmol) of methylhydrazine sulfate and 44.3 g (540 mmol) of sodium acetate in 900 mL of ethanol was heated at reflux for about 17 h under nitrogen. The mixture was concentrated and the residue was dissolved in ethyl acetate and washed three times with water and once with brine, dried over MgSO<sub>4</sub> and concentrated to give a yellow oil. The oil was stirred in 750 mL of hexane for about 3 h to give 41.17 g of 14C as a white solid. MS (CI, NH<sub>3</sub>) 344 (MH<sup>+</sup>). <sup>1</sup>HNMR (CDCI<sub>3</sub>): (partial) 8 7.19 (m, 3 H), 7.05 (m, 2 H), 4.61 (br m, 2 H), 3.24 (m, 1 H), 3.09 (s, 3 H), 3.01 (m, 1 H), 2.62 (m, 4 H), 1.52 (s, 9 H).

D. <u>3a-(R.S)-Benzyl-2-methyl-2.3a.4.5.6.7-hexahydro-pyrazolo[4.3-c]pyridir-3-one hydrochloride</u>

Anhydrous HCl was bubbled through a solution of 24.55 g (71.5 minel) of 140 in 800 mL of diethyl ether at about 0 °C for about 12 min. The mixture was stirred for about 3 h, during which time a white precipitate formed. The precipitated build was collected by filtration and to give 19.2 g of 14D. MS (CI, NH<sub>3</sub>) 244 (MH<sup>+</sup>). <sup>1</sup>HNMR (CD<sub>3</sub>OD): (partial)  $\delta$  7.25 (m, 3 H), 7.05 (m, 2 H), 3.77 (m, 2 H), 3.51 (d, 1 H), 3.25 (m, 1 H), 3.17 (m, 3 H), 3.03 (s, 3 H), 2.81 (m, 1 H).

E. 2-tert-Butoxycarbonylamino-2-methyl-propionic acid 2.5-dioxo-pyrrolidin-1-yl ester To a stirring solution of 100.0 g (492 mmol) of Boc-α-methylalanine and 94.0 g (492 mmol) of EDC in 2 L of methylene chloride at about 0 °C was added 56.63 g (492 mmol) of N-hydroxysuccinimide in portions and the reaction was then allowed to warm to room temperature. The mixture was stirred for about 24 h and washed twice each with saturated aqueous sodium bicarbonate solution and brine, dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated to give 124.0 g of 14E as a white solid. <sup>1</sup>HNMR (CDCl<sub>3</sub>): δ 4.96 (br, 1H), 2.82 (s, 4H), 1.66 (s, 6H), 1.48 (s, 9H).

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- organic; nase was washed with below, of 51 over 2012 and 40 fm. 650 g of 14F as a white solid. <sup>1</sup>HNMR (CD<sub>3</sub>OD): (partial) 8 7.55 (d, 1 H), 7.29 (m, 5 H), 4.52 (m, 1 H), 4.48 (s, 2 H), 3.84 (d of d, 1 H), 3.69 (d of d, 1 H), 1.42 (s, 6 H), 1.38 (s, 9 H).
- G. <u>3a-(R)-Benzyl-2-methyl-2,3a,4,5,6,7-hexahydro-pyrazolo[4,3-c]pyridin-3-one L-tartrate</u>
- To a mixture of 5.00 g (20.6 mmol) of the free base of 14D and 3.09 g (20.6 mmol) of L-tartaric acid in 80 mL of acetone and 3.2 mL of water was heated under nitrogen at about 70 °C for about 70 h, during which time the reaction mixture became a thick suspension and an additional 20 mL of acctone was added. The reaction mixture was cooled slowly to room temperature and then filtered. The solid that was collected was washed with acetone and dried under vacuum to give 7.03 g of 14C as a white colid.
- 20 H. <u>3a-(R)-Benzyl-2-methyl-2.3a,4.5.6.7-hexahydro-pyrazolo[4.3-c]pyridin-2 one</u>
  To a suspension of 5.00 g (12.7 mmol) of 14G in 80 mL of methylene chloride at about 0 °C was added 1.72 mL (25.4 mmol) of ammonium hydroxide and the mixture was stirred for about 15 min. The cold solution was filtered and used immediately in the next step.
- 25 I. <u>{1-[2-(3a-(R)-Benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethylcarbamoyl]-1-methyl-ethyl}-carbamic acid tert-butyl ester</u>

A mixture of 4.83 g (12.7 mmol) of 14F, the solution from 14G, 2.60 g (19.1 mmol) of HOAT, and 2.45 g (12.8 mmol) of EDC was stirred at about 0 °C under nitrogen for about 1 h and then warmed to room temperature and stirred for about 16 h. The mixture was filtered and the filtrate was washed with saturated aqu ous sodium

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bicarbonate and water, dried over MgSO<sub>4</sub> and concentrated to give 7.35 g of **141** as

pyrazolo[4.3-c]nyridin-5-yl)-1-(R)-(1H-indol-3-vlmethyl)-2-oxo-ethyll inabuturamida

added 3.5 mL of cold trifluoroacetic acid and the mixture was stirred for about 1 h at

about 2 h. The mixture was concentrated and co-evaporated twice with toluene. The residue was dissolved in chloroform and washed twice with saturated aqueous sodium bicarbonate and once each with water and brine. The mixture was dried over MgSO4 and concentrated to give 594 mg of 14J as an oil.

#### Example 15

2-Amino-N-[1-(R)-benzyloxymethyl-2-(2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolof4,3-clpyridin-5-yl)-2-oxo-ethyll-isobutyramide hydrochloride

15 A. 2-Methyl-3-oxo-2.3.3a.4.6.7-hexahydro-pyrazolo[4.3-c]pyridine-5-carboxylic acid tert-butyl ester

A mixture of 3.00 g (11.66 mmol) of 3A and 537 mg (11.03 mmol) of methylhydrazine in 100 mL of ethanol was heated at reflux for about 17 h. The mixture was concentrated and the residue was dissolved in 100 mL tehrane and heated at reflux for about 17 h. The mixture was diluted with ethyl acctate, and washed twice with brine, dried over MgSO<sub>4</sub> and concentrated. The residue was purified by silica gel chromatography using an elution gradient of 100% ethyl acetate to 5% methanol in methylene chloride to give 2.28 g of 15A as a white solid. <sup>1</sup>HNMR (CD<sub>3</sub>OD): δ 4.20 (s, 2H), 3.67 (t, 2H), 3.43 (s, 3H), 2.58 (t, 2H), 1.43 (s, CH).

B. 2-Methyl-2.3a.4.5.6.7-hexahydro-pyrazoloji.3-cjpyridin-3-one hydrochiolic

To 510 mg (2.01 mmol) of 15A in 30 mL of ethanol was added 10 mL of concentrated HCl and the mixture was stirred at room temperature for about 35 min. The mixture was concentrated and the residue was crystallized from methanol/ethyl acetate to give 425 mg of 15B as a yellow solid. <sup>1</sup>HNMR (CD<sub>3</sub>OD): δ 4.27 (S, 2H), 3.71 (S, 3H), 3.56 (T, 2H), 3.05 (T, 2H).

- [1-[1-(R)-Benzyloxymethyl-2-(2-mathyl-3 nxo-2,3.3a.4.6.7-hexahydro C. EVILLE 1113 July 11 Jin-5-yh-2 oxo at 11 1 1 1 methyl attent or 1 and a said tool
- Applications to the matthed outline that Or and Depending Ay 100 agriculture to and the residue was purification silica gel chromatography (95:5 v/v methy..... chlonde.methanol) to give a mig or 133 - 122 ... Cha. Mo (C1) 41 3, 510 (MALL)
- 2-Amino-N-[1-R-benzyloxymethyl-2-(2-methyl-3-oxo-2, 3, 3a, 4, 6, 7-hexahydro-D. pyrazolo[4.3-c]pyridin-5-yl)-2-oxo-ethyl]-isobutyramide hydrochloride
- To 54 mg (0.10 mmol) of 15C in 30 mL of ethanol was added 10 mL of concentrated 10 HCl and the mixture was stirred at room temperature for about 40 min. The mixture was concentrated and the residue was precipitated from methanol/ethyl acetate to give 50 mg of 15D. MS (CI, NH<sub>3</sub>) 416 (MH<sup>2</sup>). 1 rINMR (CD<sub>3</sub>OD): (2000) 7772 cm. 5 H), 5.18 (m 1 H), 4.69-4.38 (m, 4 H), 3.88 (m, 1 H), 3.73 (m, 2 H), 3.68 (s, 2 H), 15 3.61 (m, 1 H), 2.67 (m, 1 H), 1.57 (s, 6 H).

#### Example 16

2-Amino-N-[2-(2-benzyl-3-oxo-2,3,3a,4,6,7-haxahydro-pyrazolo[4,3-c]pyridin-5-yl)-1(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyll-isabityramide hydrochloride

A. 2-Benzyl-3-oxo-2.3.3a.4.6.7-hexahydro-pyrazolo[4.3-c]pyridine-5-carboxylic acid tert-butyl ester

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A mixture of 800 mg (3.11 mmol) of 3A and 495 mg (3.11 mmol) of bearyl-hydrazine dihydrochloride in 15 mL of ethanol was heated at reflux for about 17 h. The mixture was concentrated and the residue was dissolved in 100 mL toluene and heated at reflux for about 48 h. The mixture was diluted with ethyl acetate, and we had twice with brine, dried over Na2SO4 and concentrated. The residue was purified by silica gel chromatography using an elution gradient of 100% ethyl acetate to 5% methanol in methylene chloride to give 530 mg of 16A as a tan solid. MS (CI, NH<sub>3</sub>) 330  $(MH^+).$ 

2-Benzyl-2.3a.4.5.6.7-hexahydro-pyrazolo[4.3-c]pyridin-3-one hydrochloride B. To 411 mg (1.24 mmol) of 16A in 30 mL of ethanol was added 10 mL of 30 concentrated HCI and the mixture was stirred at room temperature for about 30 min. The mixture was conc ntrated and the residue was crystallized from methanol/ethyl

- To a stirring or hitten of 30.6 g (0.15 mol) of D typtophan, 30.4 g (0.30 mol) of the methylmorpholine in 450 mL of (4:1) diaxane; water, was added 45.0 g (0.15 mol) of 142 and the litture was stirred for the 170 h. Thousand diaxane made in 15, evaporation and water and ethyl acetate ware added to the mixture. The FM of the solution was adjusted to 3 with concentrated HCI and the layers were separated.
- The organic layer was washed with water and brine, dried over MgSO<sub>4</sub> and concentrated. The residue was crystallized from ethyl acetate/hexanes to give 37.0 g of an off-white solid.
  - D. 41 In In the Self-Carp 0.2.0 u4.0.014 (R)-(1H-indol-3-ylmethyl)-2-oxo-ethylcarbamovil-1-mathyl uthyllaculbunia politik it
- 15 butyl ester

According to the method outlined in General Procedure A, 100 mg (0.38 mmol) of 16B and 202 mg (0.53 mmol) of 16C were coupled and the residue was profiled by silica gel chromatography (95:5 v/v methylene chloride:methand!) to give 45 mg of 16D as a white solid. MS (CI, NH<sub>3</sub>) 601 (MH<sup>+</sup>).

- E. 2-Amino-N-[2-(2-benzyl-3-oxo-2.3.3a.4.6.7-hexahydro-pyrazolo[4.3-c]pyridin-5-yl)-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyl)-isobsity amids hydrochlaride

  To 45 mg (0.07 mmol) of 16D in 60 mL of ethanol was added 20 mL of concentrated HCl and the mixture was stirred at room temperature for 35 min. The mixture was concentrated and the residue was producted from methanol/athyl actual to give
- 30 mg of 16E. <sup>1</sup>HNMR (CD<sub>3</sub>OD): (partial) δ 7.40 (m, 4 H), 7.25 (m, 3 H), 7.11 (m, 2 H), 6.96 (m, 2 H), 6.81 (m, 1 H), 5.38 4.93 (m, 3 H), 4.46 (m, 1 H), 4.22 (m, 1 H), 3.96 (m, 1 H), 3.69 (m, 1 H), 3.18 (m, 1 H), 2.28 (m, 1 H), 1.57 (m, 6 H),1.38 (m, 1 H).

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#### Example 17

A CHARLES OF THE STATE OF THE S

A. 3-Methyl-4-oxo-piperidine-1,3-dicarloxylla colid 1 tart butyl 19tan 2 (1), (1) morti sit ester

mmol) of sodium by 12.00 g (7.77 minol) and the minutes was stirred at room temperature for about 25 min. To the utirring solution was added 0.50 mL (7.77 mmol) of methyl iodide and the mixture was stirred for about 17 h at room temperature. The mixture was diluted with ethyl acetate and washed once with water and four times with brine, dried over MgSO<sub>4</sub>, and concentrated. The residue was purified by silica gel chromatography (7:3 v/v hexanetethyl acetate) to give 1.75 minor of the content of th

b. <u>2.3a-711 С Cimellay 13. 08-21.5 (1.111 д. 1.111 д. 1.111 д. 1.111 д. 1.111 д. 1.111 д. 1.</u>

## 15 carboxylic acid tert-butyl ester

A mixture of 1.62 g (9.50 mmol) of 17A and 435 mg (9.50 mmol) of methylhydrazine in 30 mL of ethanol was heated at reflux for about 4 h. The mixture was concentrated and the residue was disselved in 50 mL toluene and heated at reflux for about 14 h. The mixture was diluted with ethyl acetate, and wasted twice with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated. The residue was purified by silica get chromatography (7:3 v/v haxonosothyl acetate) to 3/4 1.00 g of 17B as a white solid. MS (CI, NH<sub>3</sub>) 268 (MH<sup>+</sup>).

- C. 2.3a-(R.C)-Dimethyl-2.3a.4.5.6.7-haxuliy.d.a pyrazuls[4.3.slpvrid] = 3. min. hydrochana
- To 1.00 g (3.74 mmol) of 17B in 40 mL of ethanol was added 8 mL of concentrated HCl and the mixture was stirred at room temperature for about 35 min. The mixture was concentrated and the residue was crystallized from methanol/ethyl acetate to give 850 mg of 17C as a white solid. MS (CI, NH<sub>3</sub>) 168 (MH<sup>+</sup>).

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D. <u>{1-[1-(R)-Benzyloxymethyl-2-(2,3a-(P,9)-dimethyl-3-oxo-2,3,3a,4,9,7</u>}</u>
beyabydro-pyrazolof4 3-clayridin 5-yl) 2 explethylogramovil 4-methyl othyl) carbonic acid fort bytyl ester.

According to the method outlined in Co... I hipposture A, 100 mg (2011 - 1) of

17C and 514 mg (1.35 mmol) of 1E were coupled and the residue was purified by

The control of methods as a first of the control of the solid.

- E. 2-Amino-N-[1-(R)-benzyloxymethyl-2-(2-3a-(R,S)-dimethyl-2-axo-ethyl-isobutyramida hydrochloride
- To 173 mg (0.33 mmol) of 17B in 40 mL of ethanol was added 15 mL of concentrated HCl and the mixture was stirred at room temperature for about 1 h. The mixture was concentrated and the residue was diluted with 11 referm and washed with saturated aqueous 90.3% and bring 13 mL.
- and the residue was purified by silica gel chromatography using an elution gradient of 100% ethyl acetate to 10% diethylamine in ethyl acetate. The residue was dissolved in ethanol and acidified with aqueous HCI. The mixture was concentrated and the residue was crystallized from methanol/ethyl acetate to give 65 mg of 17E as a white solid. MS (CI, NH<sub>3</sub>) 502 (F\*F\*). THMMR (CD3OD): (particl) 0.7.32 (m, 5.H),
- 20 5.14 (m, 1 H), 4.53 (m, 3 H), 3.71 (m, 3 H), 2.97 (m, 1 H), 2.83 (m, 1 H), 2.57 (m, 1 H), 1.98 (m, 2 H), 1.61 (m, 6 H), 1.38 (s, 3 H).

#### Example 18

2-Amino-N-[2-(3a-(R)-benzyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide hydrochloride and 2-Amino-N-[2-(3a-(S)-benzyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide hydrochloride

A. 3-Benzyl-4-oxo-piperidine-3-carboxylic acid methyl ester

To 200 mg (0.58 mmol) of **3B** at about 0 °C was added 5 mL of cold trifluoroacetic acid and the mixture was stirred for about 1 h. The mixture was concentrated and the residue was co-evaporated with ethyl acetate and hexane. To the residue was added 2N NaOH to make it basic and the mixture was extracted with chloroform.

The combined organic extracts were dried ever MgSO4 and concentrated to give Land the plane dilution of mine.

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- According to the method outlined in Control Proceedings (7.17 a (7.17 a a 2)) and Jour g (a.d Millary or that were doing as in give the second was purmed by ellips of the control of the control of the give 820 mg of less polar 18B isomer 1 and 1.14 g more polar 100 isomer 2, IMC (Cl. NH<sub>3</sub>) 611 (MH<sup>+</sup>) for both isomers.
- {1-[2-(3a-(R,S)-Benzyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-C. 10 5-vI)-1-(R)-benzyloxymethyl-2-oxo-ethylcarbamoyl]-1-methyl-ethyl)-carbamic acid tert-hutvl ester The production of the control of the
  - 342 mg (2.63 mmol) of hydrazine sulfate and 431 mg (5.26 mmol) of sodium acct in and the mixture was heated at reflux for about 17 h. The mixture was concentrated and the residue was diluted with ethyl acetate and washed with saturated aqueous sodium bicarbonate and brine, dried over MgSO4 and concentrated. The residue was purified by silica gel chromatography using an elution gradient of 75% ethyl acetate in hexane to 100% ethyl acetate to give 550 mg of 100 laumor 1.
  - To a solution of 1.14 g (1.86 mmol) of 18B isomer 2 in 20 mL of ethanol was added 485 mg (3.73 mmol) of hydrazine sulfatu and 013 mg (7.48 mmol) of partium quetate and the mixture was heated at reflux for about 17 h. The mixture was concentrated and the residue was diluted with ethyl acctate and washed with saturated aquacus sodium bicarbonate and brine, dried over MgSO4 and concentrated. The residue was purified by silica gel chromatography (75:25 v/v ethyl acetate/hexane) to give 710 mg of 18C isomer 2.
    - 2-Amino-N-[2-(3a-(R)-benzyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-D. clpyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide hydrochloride To 200 mg (0.34 mmol) of 18C isomer 1 in 12 mL of ethanol was added 6 mL of concentrated HCI and the mixture was stirred at room temperature for about 2.5 h. The mixture was concentrated and co-evaporated three times with ethanol to give 20 mg of 18D i om r 1. MS (CI, NH<sub>3</sub>) 492 (MH<sup>+</sup>). <sup>1</sup>HNMR (CD<sub>3</sub>OD): (partial)δ 8.42

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(br d, 1 H), 7.35 (m, 5 H), 7.18 (m, 5 H), 5.23 (m, 2 H), 4, 91 (m, 1 H), 4.54 (m, 4 H), 3.80 (m, 2 H), 3.63 (m, 1 H), 3.12 (m, 1 H), 3.07 (m, 3 H), 2.61 (m, 3 H), 1.62 (m, 1 H), 1.39 (m, 1 H).

The mixture was concentrated and co-marginal to three times with μ' = 20 mg of 18E isomer 2. MS (CI, NH3) 492 (MH<sup>+</sup>). <sup>1</sup>HNMR (CD3OD): (partial) δ 8.29 (br d, 1 H), 7.30 (m, 5 H), 7.11 (m, 4 H), 6.88 (m, 1 H), 5.29 (m, 1 H), 4.92 (m, 1 H), 4.62 (m, 3 H), 3.91-3.70 (m, 3 H), 3.22-2.95 (m, 3 H), 2.66 (m, 3 H), 1.57 (m, 6 H), 1.30 (m, 1 H), 0.89 (m, 1 H).

2.3.3.4.6.7 box shydro-pyrazolott 2. Toyotti 5.70.2 yo-albyll in the terminal

15 2.33c.4.6.7-boxahydro-pyrazolo[4.3] i wikiti 5 yiti 2 cxo-elhyll-loubi till milita dihydrochloride

A. 4-Oxo-3-(R.S)-thiazol-4-ylmethyl-piperidine-1 3-dicarboxylic acid 1-tert-butyl ester 3-ethyl ester

To a solution of 300 mg (1.10 mme) of 1A in 5 mL of THF at about 0 °C was added 67 mg (1.66 mmol) of sodium hydride (60% oil dispersion) and the mixture was stirred for about 30 min. A solution of 204 mg (1.21 mmol) of 4-chica antihylthiazole (Hsiao, C. N; Synth. Comm. 20, p. 3507 (1990)) in 5 mL of THF was added to the cold solution, followed by 87 mg (0.53 mmol) of potassium indice and the mixture was heated at reflux for about 17 h. The mixture was diluted with water and extracted with ethyl acetate. The combined organic extracts were dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated and the residue was purified by silica gel chromatography (7:3 v/v hexane:ethyl acetate) to give 90 mg of the title compound. MS (CI, NH<sub>3</sub>) 648 (MH<sup>+</sup>).

- B. 2-Methyl-3-oxo-3a-(R,S)-thiazol-4-ylmethyl-2,3,3a,4.6,7-hexahydro-
- 30 <u>pvrazolo[4.3-c]pvridine-5-carboxvlic acid tert-butvl ester</u>

To 90 mg (0.24 mmol) of **19A** in 2 mL of ethanol was added 11.2 mg (0.24 mmol) of methylhydrazine and the mixture was heated at reflux for about 17 h. An additional

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- 33.6 mg (0.72 mmol) of methylhydrazine was added and the mixture was horted at reflect for the first of the mixture was horted at a mixture for the first of the mixture was discretion to a mixture realization as purined at reflect for the first of the mixture was discretion to a mixture realization as purined at a first of the mixture was discretion to a mixture of the mixture was discretion to a mixture was discretion and discretion to a mixture was discretion to a mixture
- Covered the same services of the services of t

A mixture of 44 mg (0.10 mmol) of 19B in 1 mL of 4M HCl in dioxed was stirred at room temperature for about 4 h. The mixture was concentrated and co-evaporated with methylene chloride to give 40 mg of 19C. MS (CI, NH<sub>3</sub>) 251 (MH<sup>+</sup>).

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According to the method outlined in General Procedure A, 40 mg (0.12 mmol) of 100 and 39 mg (0.12 mmol) of 14F were coupled and the residue was purified by silica gel chromatography (9:1 v/v ethyl acetate:hexane) to give 40 mg of 19D. MS (CI, NH<sub>3</sub>) 613 (MH<sup>+</sup>).

- E. 2-Amino-N-[1-(R)-benzyloxymethyl-2-(2-methyl-3-oxo-3a-(R,S)-thiazol-4-ylmethyl-2.3.3a.4.6.7-hexahydro-pyrazolo(4.3-c]pyridin-5-yl)-2-oxo-ethyl]-
- 20 isobutyramide dihydrochloride

A mixture of 40 mg (0.06 mmol) of 19D in 1 mL of 4M HCI in dioxane was stirred at room temperature for about 5 h. The mixture was concentrated and co-evaporated with methylene chloride to give 40 mg of 19E. MS (CI, NH3) 513 (MH+).

### Example 20

- 25 2-Amino-N-[2-(3a-(R)-benzyl-2-methyl-3-oxo-2.3.3a,4.6.7-hexahydro-pyrazolol4.3-c]pyridin-5-yl)-1(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyl]-isobutyramide L-tartaric acid salt
  - To 4.6 g of the title compound of Example 14 in 20 mL of methanol, a solution of 1.36 g of L-tartaric acid in 20 mL of methanol was added at about 0° C. The mixture was warmed to room temperature, stirred for about 40 min and concentrated in vacuo. The residue was diluted with 220 mL of ethyl acetate, heated at reflux for

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about 1.5 h, then stirred at about 72° C for about 18 h. The mixture was cooled to room temporature, and filtered to give 5.78 d of the title compound as a colorive.

5 3-Benzyl-3-mothoxycarbonylmethyl-4-oxo\_pina\_1 line\_1-carboxylic\_acid\_tert\_butyl\_ester

A. 3-Benzyl-4-oxo-pineridine-1-carboxylic\_acid\_tert\_butyl\_ester

mixture was cooled to room temperature and extracted with EtOAc (3 x 100 mL). The combined extracts were dried and concentrated *in vacuo*. The crude product was chromatographed on  $SiO_2$  using 20% ethyl acetate/hexanes to give 1020 mg of the desired product as a yellow oil. <sup>1</sup>H NMR (250 mHz, CDCl<sub>3</sub>): d: 7.4 (m, 5H), 4.2

417, 140 (11 01), 130 (M+1-BUC).

15 B. <u>3-Benzyl-3-methoxycarbonylmethyl-4-oxo-piperidine-1-carboxylic acid tert-butyl ester</u>

A solution of the product from Step A of Example 21 above (1320 mg, 4.50 mmol), pyrrolidine ( 972 mg, 13 mmol) and p-toluenesulfonic acid (33 mg) in benzene (30 ml) was refluxed through 3.5 molecular sieves for about 17 h. The reaction mixture was cooled to room temperature and concentrate J in value. The residue was dissolved in benzene (10 ml) and cooled to about 0 °C. Mathyl bromoacetate (1530 mg, 10 mmol) was added dropwise. The reaction mixture was slowly allowed to warm to room temperature and then was heritable. For reflux for about 17 h at which point  $H_2O$  (5 mL) was added. After refluxing for about another 2 h, the reaction mixture was cooled to room temperature and extracted with EtCAs (3 x 100 ml). The combined organic extracts were dried and concentrated in vacuo. The crude residue was chromatographed on  $SiO_2$ -gel using 15% ethyl acetate/ hexanes to give 280 mg of product.  $^1H$  NMR (250 MHz, CDCl<sub>3</sub>): d 7.35 (m, 5 H), 4.5 (m, 1 H), 3.8 (s, 3H), 3.4 (dd, 1 H), 3.1 (m, 1 H), 2.85 (m, 4H), 2.6 (m, 1 H), 2.4 (m, 1 H), 1.5 (s, 9 H); MS (APCl): 362 (M+1).

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-108-

#### Example 22

appropriate the second second

was heated to about 40 °C. Lead tond 1000 (100 mg, 200 mm), small portions and the groundship yellow solution in 2000 1 of about 40 °C f.

The β-ke/cluster (52) and 0.0 mmol) rand the added, for each by hydronic (52) and (52) are second for hydronic (52).

concentrated *in vacuo* and the residue was dissolved in erner (100 mi) and one of the filtrate was washed with 3N  $H_2SO_4$  (3x), dried and concentrated to give 616 mg of a yellow solid. Flash chromatography over  $SiO_2$ -gel using 25% ethyl acetate/hexanes provided 368 mg of the decired product. <sup>1</sup>H NMA (100 1115, CDCl<sub>3</sub>): d 7.15 (m, 5 H), 4.4 (s, 2 H), 3.7 (s, 5 H), 2.6 (s, 2 H), 1.5 (s, 9H); MS

## Example 23

15 (D)-2-Amino-3-(2.4-dichloro-benzyloxy)-propionic acid hydrochloride

A. (D)-2-tert-Butoxycarbonylamino-3-(2.4-dichloro-benzyloxy)-propionic acid

To a stirred solution of Boc-D-serine (3.2 g, 40 mmol) in DMF (75 ml) at about 0°C was added NaH (60% dispersion, 3.2 g, 80 mmol) over about a 10 minute period. The reaction mixture was stirred for about 1.75 h at about 0°C, then about 0.25 h at room temperature. After cooling to about 0°C, a solution of 2,4-dichlorotoluene (5.56 ml, 40 mmol) in DMF (5 ml) was added dropwisa. The reaction mixture was allowed to warm to about 23°C and was stirred for about 17 h, then was partitioned between di icopropylether and 10% MCI. This agreement addition was extracted with di-isopropyl ether (2x). The combined extracts were washed with saturated aqueous brine, dried and concentrated to give 14.75 g of ord 2 profine which was used without further purification. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): d 7.6-7.2 (m, 3 H), 5.4 (d, 1 H), 4.6 (s, 2 H), 4.0 (d, 1 H), 3.8 (dd, 2 H), 1.1 (s, 9H); MS (APCI): 264,266 (M+1, M+2).

B. (D)-2-Amino-3-(2.4-dichloro-benzyloxy)-propionic acid hydrochloride

The product from step A of Example 23 above (14.7 g, 40 mmol) was stirred in 4 M HCl/dioxane (100 ml) for about 17 h. The reaction mixture was concentrated in vacuo to give 12 g of a pale yellow solid (100%). MS (APCI): 265 (M+1).

#### Example 24

Example 24 having the formula chause below

wherein R<sup>1</sup> is -CH<sub>2</sub>-phenyl and R<sup>2</sup> is methyl, was synthesized in an analogous manner to the procedures described in Examples 3C to 3F using the title compound of Example 21 as starting material. Both the R<sub>1</sub>R and S<sub>2</sub>R diastereometric (\* indicates the other stereoisomer center at the C-3 carbon of the above structure) visits isolated. Mass spec. (M+1)= 520; MS method = particle bombardment.

10 Examples 25 and 26 having the formula shown below.

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wherein for both examples 25 and 25  $\rm R^4$  is phenyl and  $\rm R^2$  is methyl, where example 25 is the R<sub>1</sub>R isomer and example 26 is the S<sub>2</sub>R isomer. Examples 25 and 26 were synthesized in an analogous manner to the procedures described in Example 30 to 3F using the title compound of Example 22 as starting material followed by chromatographic separation of the two separate isomers. Mass spect of each example (M+1)= 493, MS method= particle bombardment.

#### **Examples 27-159**

Examples 27 to 159 listed in the table below, were prepared according to the scheme illustrated below by coupling the appropriately substituted pyrazalone-piperidine of formula I (in the below scheme) with the (D)-OBnSer derivative II (in the below scheme) in an analogous manner to the procedures described in Examples 3E and 3F.

The pyrazide...s-piperiames of formula have propared introduced, and all procedures described in Examples 3B and 3C starting with the appropriate allegating agent and alkylhydrazine; the (D)-OBnSer derivatives (II) were prepared in three steps analogously to the procedures described in Example 23A, Example 23B and Example 5F.

Ex. #	Isomer	R <sup>2</sup>	$R^1 = -CH_2 - A^1$	Ar	MS	MS
						Method
27	d1	1-i	2-pyridyl	phenyl	493	PB
28	d1	Н	4-thiazolyl	phenyl	499	PB
29	d2	Ħ	4 thiazolyl	phenyl	400	PB .
30	d1	H	5 thiazolyl	phenyl	499	APCI
31	d1	Ме	phenyl	2,4-di-Cl-Ph	574.5	APCI
32	d1	Me	phenyl	2,4-di-F-Ph	542	PB
33	d1	Ме	phenyl	[2,3-O-CH <sub>2</sub> -O]Phenyl	550.2	PB
34	d1	Ме	phenyl	2-CF <sub>3</sub> -Ph	<b>57</b> 5	PB
35	d1	Ме	phenyl	2-Me-Ph	520	PB
36	d1	Me	phenyl	2-pyridyl	507	PB
37	d1	Me	phenyl	3,4-di-F-Ph	542	PB
38	d1,2	Me	phenyl	3,5-di-CF <sub>3</sub> -Ph	642	PB
39	<b>d</b> 1	Me	phenyl	3,5-di-Cl-Ph	576	APCI

WO 97/24369 PCT/IB96/01353

-111-

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40	d2	Me	phenyl	3-CF <sub>3</sub> -Ph	575	APCI
41	d1	Me	phenyi	3 Cl-Ph	540	AT CI
10	1.1	f *	ا روجوهم	2010	F10 F10	4 · * * *
• •		•				100
4.,4	41	ħ 4 m	entra erra et	o Ma Di		D.D.
45	d1	Me	phenyl	4-CI-Ph	540	FB
<b>44</b> 1,	•	*	p. 1611.j.i	14 ( ) ( ) ( ) ( ) ( ) ( ) ( )	301	ř.
47	d1	Mu	phenyl	4-thiazut, t	513	PP
46	d1	Me	phenyl	5-thiazolyl	513	APCI
49	d1,2	ਿਰ	phenyl	benzisoxazoryi	547	د٦
50	d1	Ме	phenyl-	4-pyrimidinyl	508	PB
51	d1,2	Me	4-Ph-Ph	4-thiazoly!	539	APCI
52	d1,2	Me	4-Ph-Ph	2-pyridyl	583	APCI
<b>5</b> 3	d1	Me	4-F-Ph	phenyl	524	PB
54	d2	Μc	4-F-Ph	phenyl	524	PB
55	d1	Ме	4-F-Ph	3-CI-Ph	558	PB
56	d2	Me	4-F <b>-</b> Ph	3-Cl-Ph	558	PB
57	d1	Me	4-F-Ph	3,4-di-F-P <b>h</b>	560	APCI
58	d2	Ме	4-F-Ph	3,4-di-F-Ph	560	APCI
59	d1,2	Me	4-F-Ph	2-pyridyl	525	APCI
60	d1,2	Me	4-F-Ph	2-CF <sub>3</sub> -Ph	592	APCI
61	d1	Me	4-CF <sub>3</sub> -Ph	4-CI-Ph	609	APCI
62	d1,2	Me	4-CF <sub>3</sub> -Ph	4-Cl-Ph	609	APCI
63	d1,2	Me	3-pyridyl	phe <b>nyl</b>	508	PB
64	d1	Ме	3-p <b>h</b> enyl	3-py <b>rid</b> yl	508	PB
65	d1	Ме	2-quinolinyl	phenyl	594	PB
66	d2	Ме	2-quinolinyl	ph <b>enyl</b>	594	PB
67	d1	Me	2-pyridyl	phenyl	506	PB
68	d2	Me	2-pyridyl	phenyl	506	PB
69	d1,2	Me	2-pyridyl	3-F-4-Cl-Ph	559 <b>, 56</b> 1	APCI
70	d1	Me	2-pyridyl	3-Cl-thiophene	5 <b>47, 549</b>	APCI
71	d1	Ме	2-pyridyl	3-CF <sub>3</sub> -Ph	575	PB
72	d1,2	Me	2,4-di-F-Ph	3,4-di-F-Ph	579	APCI
73	d1,2	Me	2,4-di-F-Ph	2-pyridyl	544	PB
74	d1	Ме	4-thiazolyl	phenyl	513	APCI
75	d2	Me	4-thiazolyl	phenyl	513	PB

PCT/IB96/01353 WO 97/24369

-112-

76	d1	Me	5-thiazolyl	phenyl	513	ГB
77	d1	<u>i</u>	2-pyridyl	phonyl	521	טרו
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<i>(</i> ,		<u></u>		٠٠٠ ا		
		·				
81	d1	Et	2,4-di-F-Ph	2,4-di-F-Ph	592	APCI
82	d2	Li.	2,4-0,-1-17	2,4 01 1 1 11	<b>U</b> , U	ŕ.
83	d1	⊨t	2,4-di-F-Ph	2 CF <sub>3</sub> -i	625	APCI
84	d2	Et	2,4-di-F-Ph	2-CF <sub>3</sub> -Ph	625	APCI
85	d1	Et	2,4-di-F-Ph	3,4-di-F-Ph	593	APC:
86	d2	Εt	2,4-di-F-Ph	3,4-di-F-Ph	593	APCI
87	d1	El	2-pyridyl	3,4-di-F-( i)	C 37	PD
88	d2	Et	2-pyridyl	3,4-di-F-Ph	607	PB
89	d1	Et	4-CF <sub>3</sub> -Ph	2,4-di-F-Ph	625	APCI
90	d2	Li	4-CF <sub>3</sub> -Ph	2, e-di 7 75	025	APOL
91	<b>d</b> 1	Et	4-CF <sub>3</sub> -Ph	3-CI-Ph	623	APCI
92	d1	Et	4-CF <sub>3</sub> -Ph	4-CI-Ph	623	APCI
93	d2	Et	4-CF <sub>3</sub> -Ph	4-CI-Ph	623	APCI
94	d1	Et	4-CH <sub>3</sub> -Ph	3-CI-Ph	568	APCI
95	d2	Et	4-CH <sub>3</sub> -Ph	3-CI-Ph	568	APCI
96	d1	Et	4-Cl-Ph	3,4-di-F-Ph	590	PB
97	d2	Et	4-CI-Ph	3,4-di-F- <b>Ph</b>	59 <b>0</b>	PB
98	d1	Et	4-CI-Ph	3-5-di-Cl-Ph	622	PB
99	d2	Et	4-Cl-Ph	3-5-di-Cl-Ph	622	PB
100	d1	Et	4-CI-Ph	3-Cl-Ph	589	PB
101	d2	Et	4-CI-Ph	3-Cl-Ph	589	PB
102	d1	Et	4-F-Ph	3,4-di-F-Ph	574	PB
103	d2	Et	4-F-Ph	3,4-di-F-Ph	574	PΒ
104	<b>d</b> 1	Et	4-F-Ph	3-Cl-Ph	572	APCI
105	d2	Et	4-F-Ph	3-CI-Ph	572	APCI
106	d1,2	Et	4-Me-Ph	2-CF <sub>3</sub> -Ph	602	APCI
107	d1,2	. Et	4-Me-Ph	3,4-di-F-Ph	570	APCI
108	d1,2	CF₃CI	H <sub>2</sub> phenyl	4-thiazolyl	<b>59</b> 5	APCI
109	d1	CF <sub>3</sub> CI	H <sub>2</sub> phenyl	3-CF <sub>3</sub> -Ph	642.3	APCI
110	d1	CF <sub>3</sub> Cl	H <sub>2</sub> phenyl	3,5-di-Cl-Ph	643	APCI
111	d2	CF <sub>3</sub> C	H <sub>2</sub> phenyl	3,5-di-C1-Ph	644	APCI

-113-

112	d1	CF <sub>3</sub> CH <sub>2</sub> phenyl	3,4-di-F-Ph	610.2	APCI
113	d2	CF <sub>3</sub> CH <sub>2</sub> phenyl	3,1 41 5 75	640,7	Ann
114	4 '	ar all abonyl	2 = 11 01 01	643	1201
•	. •	07/11 . Lat 1	r / r	** • •	
	•	OF OH, about	· · · · · · · · · · · · · · · · · · ·	200	,
11/	di	C-3CH <sub>2</sub> phenyl	3,1-014-176	. 0.2	i
	r -,	Commence of	200	•	
119	d1,2	CF_CH2 phenyl	4-(1-2-1)1	595	Λ., ·
120	d1,2	CF <sub>3</sub> CH <sub>2</sub> 2,4-di-Cl-Ph	2-pyridyl	643	APCI
121	d1,2	CF3CH2 2,4-di-Cl-Ph	4-thiazolyl	649	APCI
122	d1	CF <sub>3</sub> CH <sub>2</sub> 2,4-F-Ph	2-CF <sub>3</sub> -Ph	679	APCI
123	d2	CF <sub>3</sub> CH <sub>2</sub> 2,4-F-Ph	2-CF <sub>3</sub> -Ph	679	APC1
124	d1	CF <sub>3</sub> CH <sub>2</sub> 2,4-F-Ph	3,4-di-F-Ph	647	APCI
125	d2	CF <sub>3</sub> CH <sub>2</sub> 2,4-F-Ph	<b>3</b> ,4- <b>di-</b> F-Ph	647	APCI
126	d1,2	OF-OH- 2,1-F FIN	4 this solut	. 17	Fi
127	d1	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	2,4-di-Cl-rh	643	F. C:
128	d2	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	2,4-di-Cl-Ph	643	APCI
129	d1	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	2,4 <b>-di-</b> F-Ph	611	PB
130	d2	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	2,4-di- <b>F-</b> Ph	611	PB
131	d1	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	2-CF <sub>3</sub> -4-F-Ph	661	APCI
132	d1	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	2-CF <sub>3</sub> -Ph	643	PB
133	d2	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	2-CF <sub>3</sub> -Ph	643	PB
134	d1	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	3,4-di-F-Ph	611	PB
135	d2	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	3,4-di-F-Ph	611	PB
136	d1	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	3,5-di-Cl-Ph	643	APCI
137	<b>d</b> 1	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	3-CI-Ph	609	PB
138	d1	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	3-CI-thiophene	615, 617	APCI
139	d1,2	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	3-F-4 CI Ph	627, 629	APCI
140	d1	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	3-OCF <sub>3</sub> -Ph	659	APCI
141	d1	CF <sub>3</sub> CH₂ 2-pyridyl	4-Cl-Ph	609	PB
142	d2	CF <sub>3</sub> CH <sub>2</sub> 2-pyridyl	4-01-Ph	609	Ьu
143	d1,2	CF <sub>3</sub> CH <sub>2</sub> 3-pyridyl	2,4-di-F-Ph	612	APCI
144	d1,2	CF <sub>3</sub> CH <sub>2</sub> 3-pyridyl	2-CF <sub>3</sub> -Ph	644	APCI
145	d1,2	CF <sub>3</sub> CH <sub>2</sub> 3-pyridyl	4-CI-Ph	610	APCI
146	d1	CF <sub>3</sub> CH <sub>2</sub> 4-CH <sub>3</sub> -Ph	3-CI-Ph	622	APCI
147	d2	CF <sub>3</sub> CH <sub>2</sub> 4-CH <sub>3</sub> -Ph	3-CI-Ph	622	APCI

WO 97/24369 PCT/IB96/01353

٠-	1 -	14	l-

<b>148</b>	d1 d2	CF <sub>3</sub> CH <sub>2</sub> 4-Cl-Ph	3,4-di-F-Ph 0,1-di-11	644 211	PB
		11.			
153	d1	CF3CH2 4-CI-M	3-Cl-i ii .	J + 1.	11:
154	d1	CF <sub>3</sub> CH <sub>2</sub> 4-F-Ph	3,4-di-F-Pn	628	t d
155	d2	Uracha 4-F-Ph	3, 1 - 4-1 - 1 - 1 - 1	023	PD
156	d1	CF <sub>3</sub> CH <sub>2</sub> 4-F-Ph	3-CI-Ph	626	PB
157	d2	CF <sub>3</sub> CH <sub>2</sub> 4-F-Ph	3-CI-Ph	626	PB
158	d1,2	CF <sub>3</sub> CH <sub>2</sub> 4-Me-Ph	2-CF <sub>3</sub> -Ph	656	APCI
159	d1,2	CF <sub>3</sub> CH <sub>2</sub> 4-Me-Ph	3,4-di-7-0%	624	APOL

Note: in the above table, the isomer designation refers to the stereocnemistry at the C-3 position (indicated by the "f" in the structure) of the expanding eigeriding groups d1 and d2 refer to the ers that were chromated. Sepandid d, d1,2 refers to mixture of isomers. Abbreviations used in the table above cre: Ph is pheny!; PB is particle bombardment; and APCI is atmospheric pressure chemical ionization. The following are NMR data for the compounds of the above table as indicated. Example 37: <sup>1</sup>H NMR (400 MHz, d4-MeOH): d 7.2 (m, 5H), 5.2 (t, 1H), 4.6 (m, 3H), 3.8 (d, 2H), 3.1 (d, 1H), 3.0 (s, 3H), 2.6 (dd, 2H), 1.6 (s, 6H). Examples 67 & 68: <sup>1</sup>H NMR (300 MHz, d4-MeOH): d 8.85 (s, 1H), 8.6 (t, 1H), 8.1 (d, 1H), 8.0 (t, 1H), 7.35 (s, 5H), 5.15 (s, 1H), 4.6 (bs, 3H), 3.85 (m,2H), 3.65 (m,2H). 3.2 (s, 3H), 2.75 (m, 2H), 1.65 (s, 6H). Example 128: <sup>1</sup>H NMR (400 MHz, d4-MeOH): d 8.8 (s, 1H), 8.6 (s, 1H), 8.5 (t, 1H), 7.96 (t, 1H), 7.9 (d, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.9 (d, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.9 (d, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.96 (t, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.96 (t, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.96 (t, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.96 (t, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.96 (t, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.96 (t, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 7.96 (t, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 1H)

7.96 (t, 1H), 7.9 (d, 1H), 7.45 (d, 1H), 7.33 (d, 1H), 5.2 (s, 1H), 4.6 (s, 3H), 4.4 (m, 1H), 4.2 (m, 2H), 3.9 (m, 4H), 3.5 (m), 3.2 (m, 2H), 2.8 (dd, 2H), 1.6 (s, 6H).

Examples 129 & 130: <sup>1</sup>H NMR (400 MHz, d4-MeOH): d 8.76 (s, 1H), 8.50 (t, 1H), 7.92 (dt,2H), 7.43 (q, 1H), 6.90 (t, 1H), 5.20 (m, 1H), 4.90 (m), 4.30 (m, 1H), 4.20 (m,

1H), 3.7 - 3.4 (m), 3.30 (s, 2H), 3.20 (m, 1H), 2.80 (dd, 2H), 1.60 (s, 6H).

Example 137: <sup>1</sup>H NMR (300 MHz, d4-MeOH): d 8.7 (1, 1H), 8.45 (t, 1 H), 7.9 (t, 2 H), 7.25 (m, 4 H), 5.2 (m, 1 H), 4.95 (d, 1 H), 4.6 (s, 2H), 4.3 (m, 1 H), 3.8 (t, 2H), 3.5

20 (dd, 2 H), 2.8 (m, 1H), 2.8 (dd, 2 H), 1.6 (s, 6 H).

WO 97/24369 PCT/IB96/01353

-115-

Example 138: <sup>1</sup>H NMR (400 MHz, d4-MeOH): d 8.8 (dd, 1H), 8.6 (s, 1H), 8.5 (t, 1H), 7.95 (t, 1H), 7.9 (s, 1H), 7.3 (s, 1H), 7.0 (s, 1H), 5.2 (s, 1H), 4.85 (s, 3H), 4.4 (m, 1.40 (s, 1H), 2.2 (m, 2H), 2.5 (dd, 2H), 2.2 (1.01 m, 2.8 (dd, 2H), 4.6 (s, 2H),

и. . . , в , в , в , в <mark>8 (t, 1 H), 3.5 (на, 2</mark> н), в , в , (е в Н), 2.8 (аа, 2 Н), 1.4 в в в е

## Examples 160-179

the scheme illustrated below by coupling the appropriately substituted pyrazalone-piperidine (I) (in the scheme) with the (D)-Trp derivative (III) (see Example 2C) in an analogous manner to the procedures described in Examples 3E and 3F.

$$R^{1}$$
 + HO NHBoc  $R^{2}$   $R^{2}$   $R^{2}$   $R^{3}$   $R^{4}$   $R^{2}$   $R^{4}$   $R^{2}$   $R^{4}$   $R$ 

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Ex. # Isomer R <sup>2</sup>			$R^1 = -CH_2 - A^1$	MS	MS Method	
160	d1	Me	4-CF <sub>3</sub> -Ph	584	APCI	
161	d1,2	Me	4-CF <sub>3</sub> -Ph	584	APCI	
162	d1	Me	4-F-Ph	533	PB	
163	d2	Me	4-F-Ph	533	PB	

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d1	Me	4-Ph-Ph	591	APCI
نا در د	· .	2,170,77	per en eng	VDC.
			Patrice	
:11	Et	4-CI-Ph	5/3	PB
d2	Et	4-CI-Ph	563	PB
11,2	,	المربد يا ا	- 1-	V PC'
d1,2	Et	4-Me-Ph	543	APCI
d1,2	CF <sub>3</sub> CH <sub>2</sub>	2,4-di-Cl-Ph	651.5	APC1
d1,2	CF <sub>3</sub> CH <sub>2</sub>	<b>2,4-di-F-</b> Ph	620	APCI
d1	CF <sub>3</sub> CH <sub>2</sub>	4-CI-Ph	617	PB
d2	CF <sub>3</sub> CH <sub>2</sub>	4-CI-Ph	617	PB
21		4 L DH	fü.	v DCI
d2	( F3' H2	. : <b>h</b>	t .	
d1,2	CF <sub>3</sub> CH <sub>2</sub>		597	APCI
	d1, d2 d1, 2 d1, 2 d1, 2 d1, 2 d1 d2	d1 Et d2 Et d1,2 CF <sub>3</sub> CH <sub>2</sub> d1 CF <sub>3</sub> CH <sub>2</sub> d2	## ## ## ## ## ## ## ## ## ## ## ## ##	### ##################################

Note: in the above table, the isomer designation refers to the stereochemistry at the C-3 position (indicated by the "" in the structure) of the pyrazalone-piperidine group; d1 and d2 refer to isomers that were chromatographically separated; d1,2 refers to a mixture of isomers.

# Examples 180 - 183

Examples 180 to 183 shown in the table below were prepared according to the scheme illustrated below by coupling the appropriately substituted pyrazalone-piperidine I with the acid intermediate IV in an analogous manner to the procedures described in Examples 3E and 3F.

The acid intermediate (IV) was prepared by treating an amino acid with the product from Example 5D using the established procedure described in Example 5F.

WO 97/24369 PCT/IB96/01353

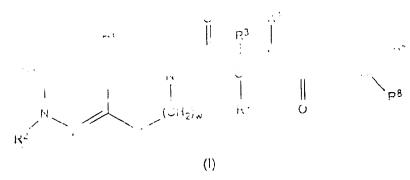
	1	rt'	13			
0ن1	d1,2	Me	Phenyl	(CH_)21 11	Sc:	
181	d1,2	MA	Pheryl	SCH <sub>2</sub> Ph	580	PR
182	d1	Me	Phenyl	2-Naphthalenyl	527	APCI
183	d1,2	Me	Phenyl	CH <sub>2</sub> O-(4-F-Ph)	524	P3

Note: in the above table, the isomer designation refers to the stereochumistry at the C-3 position (indicated by the "\*" in the structure) of the pyrazalone-piperidine group;

d1 and d2 refer to isomers that were chromatographically separated; d1,2 refers to a mixture of isomers.

#### CLAIMS

## A compound of the formula



the racemic-diastereomeric mixtures and optical isomers of said compounds and the 5 pharmaceutically-acceptable salts and prodrugs thereof,

#### wherein

a in Mort.

provided that w and n cannot both be 0 at the same time; 10

Y is oxygen or sulfur;

 $R^{1} \ \ \text{is hydrogen, -CN, -(CH_{2})}_{a}N(X^{6})C(O)X^{6}, \ -(CH_{2})_{a}N(X^{6})C(O)(CH_{2})_{t}-A^{1},$ 

 $-(CH_2)_{\alpha}N(X^6)SO_2(CH_2)_{t}-A^1, -(CH_2)_{\alpha}N(X^6)SO_2X^6, -(CH_2)_{\alpha}N(X^6)C(O)N(X^6)(CH_2)_{t}-A^1, -(CH_2)_{\alpha}N(X^6)SO_2X^6, -(CH_2)_{\alpha}N(X^6)C(O)N(X^6)(CH_2)_{t}-A^1, -(CH_2)_{\alpha}N(X^6)SO_2X^6, -(CH_2)_{\alpha}N(X^6)C(O)N(X^6)(CH_2)_{t}-A^1, -(CH_2)_{\alpha}N(X^6)SO_2X^6, -(CH_2)_{\alpha}N(X^6)C(O)N(X^6)(CH_2)_{t}-A^1, -(CH_2)_{\alpha}N(X^6)SO_2X^6, -(CH_2)_{\alpha}N(X^6)C(O)N(X^6)(CH_2)_{t}-A^1, -(CH_2)_{\alpha}N(X^6)SO_2X^6, -(CH_2)_{\alpha}N(X^6)SO_2X^6, -(CH_2)_{\alpha}N(X^6)C(O)N(X^6)(CH_2)_{t}-A^1, -(CH_2)_{\alpha}N(X^6)SO_2X^6, -(CH_2)$ 

 $-(CH_2)_qN(X^6)C(O)N(X^6)(X^6), -(CH_2)_qC(O)N(X^6)(X^6), -(CH_2)_qC(O)N(X^6)(CH_2)_t-A^1, -(CH_2)_qC(O)N(CH_2)_t-A^1, -(CH_2)_t-A^1, -(CH_2)_t-A^1, -(CH_2)_t-A^1, -(CH_2)_t-A^1, -(CH_2)_t-A^1, -(CH_2)_t-A^1, -(CH_2)_t-A^1$ 

 $-(CH_2)_qC(O)OX^6$ ,  $-(CH_2)_qC(O)O(CH_2)_t-A^1$ ,  $-(CH_2)_qOX^6$ ,  $-(CH_2)_qOC(O)X^6$ . 15

 $\textbf{-(CH_2)_qOC(O)(CH_2)_t-A}^1, \ \textbf{-(CH_2)_qOC(O)N(X}^6)(CH_2)_t-A^1, \ \textbf{-(CH_2)_qOC(O)N(X}^6)(X^6),$ 

 $-(CH_2)_qC(O)X^6$ ,  $-(CH_2)_qC(O)(CH_2)_l-A^1$ ,  $-(CH_2)_qN(X^6)C(O)OX^6$ ,

 $-(CH_2)_qN(X^6)SO_2N(X^6)(X^6), -(CH_2)_qS(O)_mX^6, -(CH_2)_qS(O)_m(CH_2)_l-A^1,$ 

 $-(C_1-C_{10})alkyl, \ -(CH_2)_l-A^1, \ -(CH_2)_q-(C_3-C_7)cycloalkyl, \ -(CH_2)_q-Y^1-(C_1-C_6)alkyl, \ -(CH_2)_q-Y^1-(C_1-C$ 

 $-(CH_2)_q-Y^1-(CH_2)_t-A^1$  or  $-(CH_2)_q-Y^1-(CH_2)_t-(C_3-C_7)$  cycloalkyl; 20

where the alkyl and cycloalkyl groups in the definition of R1 are optionally substituted with (C<sub>1</sub>-C<sub>4</sub>)alkyl, hydroxyl, (C<sub>1</sub>-C<sub>4</sub>)alkoxy, carboxyl, -CONH<sub>2</sub>,

 $-S(O)_m(C_1-C_6)$ alkyl,  $-CO_2(C_1-C_4)$ alkyl ester, 1H-tetrazol-5-yl or 1, 2 or 3 fluoro;  $Y^1$  is O,  $S(O)_m$ ,  $-C(O)NX^6$ -, -CH=CH-,  $-C\equiv C$ -,  $-N(X^6)C(O)$ -,  $-C(O)NX^6$ -,

-C(O)O-, -OC(O)N(X<sup>6</sup>)- or -OC(O)-;

q is 0, 1, 2, 3 or 4;

t is 0, 1, 2 or 3;

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said  $(CH_2)_q$  group and  $(CH_2)_t$  group may each be optionally substituted with hydroxyl,  $(C_1-C_4)$ alkoxy, carboxyl,  $-CONH_2$ ,  $-S(O)_m(C_1-C_6)$ alkyl,

$$CO_2(C_4-C_4)$$
alky! And  $C_3(C_4-C_4)$ alky!;  $C_4(C_4-C_4)$ alky!;

where the alkyl groups and the cycloalkyl groups in the definition of  $\mathbb{R}^2$  are optionally substituted with hydroxyl,  $-C(\mathbb{C}) \supset \mathbb{C}^6$ ,  $O(\mathbb{C}) \cap (\mathbb{C}^6)(X^6)$ ,  $-1^*(\mathbb{C}^6)(X^6)$ ,  $-1^*(\mathbb{C}^6)(X^6)$ ,  $-1^*(\mathbb{C}^6)(X^6)$ ,  $O(\mathbb{C}) \cap (\mathbb{C}^6)(X^6)$ ,  $O(\mathbb{C}) \cap (\mathbb{C})(X^6)$ ,  $O(\mathbb{C}) \cap (\mathbb{C})(X^6)$ ,  $O(\mathbb{C}) \cap (\mathbb{C})(X^6)$ ,  $O(\mathbb{C})(X^6)$ ,  $O(\mathbb{C})(X^6)$ ,  $O(\mathbb{C})(X^6)$ ,  $O(\mathbb{C})(X^6)$ ,  $O(\mathbb{C})(X^6)$ ,  $O(\mathbb{C})(X^$ 

 $R^3$  is  $A^1$ ,  $(C_1-C_{10})$  alkyl,  $-(C_1-C_6)$  alkyl- $A^1$ ,  $-(C_1-C_5)$  alkyl- $(C_3-C_7)$  cyclo alkyl,  $-(C_1-C_5)$  alkyl- $X^1$ - $(C_1-C_5)$  alkyl- $X^1$ - $(C_0-C_5)$  alkyl- $X^1$  or

 $-(C_1-C_5)alkyl-X^1-(C_1-C_5)alkyl-(C_3-C_7)cycloalkyl;$ 

where the alkyl groups in the definition of  $R^3$  are optionally substituted with  $-S(O)_m(C_4-C_6)$  alkyl,  $-C(O)OX^3$ , 1, 2, 3, 4 or 5 balogens, or 1, 2 or 3  $OX^3$ ;  $X^3$  is  $O_1S(O)_m$ ,  $-N(X^4)C(O)$ -,  $-C(O)N(X^4)$ -, -CC(O)-, -C(O)-, -

 $R^4$  is hydrogen, ( $C_1$ - $C_6$ )alkyl or ( $C_3$ - $C_7$ )cycloalkyl, or  $R^4$  is taken together with  $R^3$  and the carbon atom to which they are attached and form ( $C_5$ - $C_7$ )cycloalkyl, ( $C_5$ - $C_7$ )cycloalkenyl, a partially saturated or fully saturated 4- to 8 membered ring having 1 to 4 heteroatoms independently selected from the group consisting of oxygen, sulfur and nitrogen, or is a bicyclic ring system consisting of a partially naturated or fully saturated 5- or 6-membered ring, fused to a partially saturated, fully unsaturated or fully saturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen;  $X^4$  is hydrogen or ( $C_1$ - $C_6$ )alkyl or  $X^4$  is taken together with  $R^4$  and the nitrogen atom

to which  $X^4$  is attached and the carbon atom to which  $\mathbb{R}^4$  is attached and form a fire to seven membered ring;

$$X^5$$
  $X^{5a}$   $X^{5a}$   $(CH_2)_a$   $(CH_2)_b$ 

where a and b are independently 0, 1, 2 or 3;

 $X^5$  and  $X^{5a}$  are each independently selected from the group consisting of hydrog n, trifluoromethyl,  $A^1$  and optionally substituted ( $C_1$ - $C_8$ )alkyl;

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the optionally substituted ( $C_1$ - $C_6$ )alkyl in the definition of  $X^5$  and  $X^{5a}$  is optionally substituted with a substituent satisfied from the group could be a substituent satisfied from the group  $C_1$ - $C_2$ - $C_3$ - $C_4$ - $C_4$ - $C_5$ 

nitrogen atom bearing R<sup>7</sup> and R<sup>8</sup> wherein each alkylene bridge contains 1 to 5 cost on scores, provided that where on a linear single single each

 $X^{5a}$  but not both may be on the carbon atom and  $R^{5}$  or  $R^{5}$  but not both may be on the nitrogen atom and further provided E at when two alkylene bridges are formed then  $X^{5}$  and  $X^{5a}$  cannot be on the carbon atom and  $R^{7}$  and  $R^{6}$  cannot be on the nitrogen atom;

or X<sup>5</sup> is taken together with X<sup>5a</sup> and the carbon atom to which they are ring, or a partially saturated or fully saturated 4- to 6-months of the group consisting of oxygen, sulfur and nitrogen;

or X<sup>5</sup> is taken together with X<sup>5a</sup> and the carbon atom to which they are attached and form a bicyclic ring system consisting of a partially saturated or fully saturated 5- or 6-membered ring, optionally having 1 or 2 haternatoms independently selected from the group consisting of nitrogen, suffer and oxygen, fused to a partially saturated, fully saturated or fully unsaturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of nitrogen, sulfur and oxygen;

 $Z^1$  is a bond, O or N- $X^2$ , provided that when a and b are Letti 0 then  $Z^1$  is not N- $X^2$  or O;

 $R^7$  and  $R^8$  are independently hydrogen or optionally substituted ( $C_1$  C<sub>3</sub>) $^{-1}$ ryl; where the optionally substituted ( $C_1$ - $C_6$ )alkyl in the definition of  $R^7$  and  $R^8$  is optionally independently substituted with  $R^4$ ,  $-C(O)O_1$ C $_1$ - $C_6$ )alkyl,

-S(O)<sub>m</sub>(C<sub>1</sub>-C<sub>6</sub>)alkyl, 1 to 5 halogens, 1 to 3 hydroxy, 1 to 3 -O-C(O)(C<sub>1</sub>-C<sub>10</sub>)alkyl or 1 to 3 (C<sub>1</sub>-C<sub>6</sub>)alkoxy; or

 $R^7$  and  $R^8$  can be taken together to form -(CH<sub>2</sub>)<sub>r</sub>-L-(CH<sub>2</sub>)<sub>r</sub>-; where L is C(X<sup>2</sup>)(X<sup>2</sup>), S(O)<sub>m</sub> or N(X<sup>2</sup>); A<sup>1</sup> for each occurrence is independently (C<sub>2</sub>-C<sub>2</sub>)cycloalkenyl, phenyl or a partially saturated, fully saturated or fully uncaturated 4- to 8-membered ring entionally to the transfer of haternations to the control of t many in a guillance and eithe agus of the Many had a street of the age to give the time of the

heteroatoms independently selected from the group consisting of nitrogen, sulfur and The state of the s 

the aroup consisting of pitragen, suffur and overco-

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A<sup>1</sup> for each occurrence is independently applicably dubstituted, in the conoptionally both rings if A1 is a bicyclic ring system, with up to three substituents, each substituent independently selected from the group consisting of F, Cl, Br, I, OCF<sub>3</sub>, OCF<sub>4</sub>H, CF<sub>3</sub>, CH<sub>3</sub>, OCH<sub>3</sub>, -OX<sup>6</sup>,

-012) ( ), -, -, -12) -A , 0x0, ( -, -0, - ) , hill o, -, -no, benezi,

15  $-S(O)_m(C_1-C_6)$ alkyl, 1H-tetrazol-5-yl, phenyl, phenoxy, phenylalkyloxy, halophenyl, methylenedioxy,  $-N(X^6)(X^6)$ ,  $-N(X^6)C(O)(X^6)$ ,  $-SO_2N(X^6)(X^6)$ ,  $-N(X^6)SO_2$ -phenyl,  $-N(X^6)SO_2X^6$ ,  $-CONX^{11}X^{12}$ ,  $-SO_2NX^{11}X^{12}$ ,  $-NX^6SO_2X^{12}$ , -NX<sup>6</sup>CONX<sup>11</sup>X<sup>12</sup>, -NX<sup>6</sup>SO<sub>2</sub>NX<sup>11</sup>X<sup>12</sup>, -NX<sup>6</sup>C(O)X<sup>12</sup>, imidazolyl, thiazolyl and tetrazolyl, provided that if A<sup>1</sup> is optionally substituted with methylened any then it can only be substituted with one mothylenedioxy; 20

where X<sup>11</sup> is hydrogen or optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl;

the optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl defined for X<sup>11</sup> is optionally independently substituted with phenyl, phenoxy, (C1- $C_6$ )alkoxycarbonyl,  $-S(O)_m(C_1-C_6)$ nlkyl, 1 to 5 hologens, 1 to 3 hydroxy, 1 to 3 (C<sub>1</sub>-C<sub>10</sub>)alkanoylogy or 1 to 3 (C<sub>1</sub>-C<sub>10</sub>)alkanoylogy

X<sup>12</sup> is hydrogen, (C<sub>1</sub>-C<sub>6</sub>)alkyl, phenyl, thiozofyl, imidazofyl, funyl oc thienyl, provided that when X12 is not hydrogen, V12 is optioned. substituted with one to three substituents independ of contacted from

the group consisting of Cl, F, CH<sub>3</sub>, OCH<sub>3</sub>, OCF<sub>3</sub> and CF<sub>3</sub>; or X<sup>11</sup> and X<sup>12</sup> are taken together to form -(CH<sub>2</sub>),-L<sup>1</sup>-(CH<sub>2</sub>),-: where  $L^1$  is  $C(X^2)(X^2)$ , O,  $S(O)_m$  or  $N(X^2)$ ;

r for each occurrence is independently 1, 2 or 3;

X<sup>2</sup> for each occurrence is independently hydrogen, eptionshy prinstrated (C), which is a constant of the cons

, Halogolia or Foren,

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X<sup>3</sup> for each occurrence is independently hydrogen or (C<sub>1</sub>-C<sub>6</sub>)alkyl;

arkyr, optionally substituted  $(O_3 - O_7)$  optionally substituted  $(O_3 - O_7)$  optionally substituted  $(O_4 - O_6)$  will, independently substituted by 1 or 2  $(O_4 - O_6)$  will hydroxyl,  $(O_1 - O_4)$  alkoxy, carboxyl, CONII<sub>2</sub>,  $-C(D_1)$   $(O_1 - O_6)$  will, coning in (O<sub>4</sub>) alkyl ester, or 1H-tetrazol-5-yl; or

when there are two  $X^6$  groups on one atom and both  $X^6$  are independently (C.-C<sub>6</sub>)alkyl, the two (C<sub>1</sub>-C<sub>6</sub>)alkyl groups may be consultably joined at 3, to perform a storm to which the two  $X^6$  groups are attached, form a 4- to 9- membered ring optionally having oxygen, sulfur or  $NX^7$ ;

 $\rm X^7$  is hydrogen or (C1-C6)alkyl optionally substituted with hydroxyl; and m for each occurrence is independently 0, 1 or 2;

with the proviso that:

- 20  $X^6$  and  $X^{12}$  cannot be hydrogen when it is attached to  $C(\Omega)$  or  $S\cap_2$  in the form  $C(O)X^6$ ,  $C(O)X^{12}$ ,  $SO_2X^6$  or  $SO_2X^{12}$ ; and when  $R^6$  is a bond then L is  $N(X^2)$  and each r in the definition  $-(\Omega Y_1)$ , is independently 2 or 3.
  - 2. A compound according to claim 1 wherein
- 25 X4 is hydrogen;

R1 is nydrogen or meanyl,

R7 is hydrogen or (C1 C3)alky!;

 $\mathbb{R}^n$  is hydrogen or  $(C_1\text{-}C_3)$ alikyl optionally substituted with order to all  $j \in \mathbb{R}^n$  is hydrogen or  $(C_1\text{-}C_3)$ alikyl optionally substituted with order to all  $j \in \mathbb{R}^n$ 

$$Z^1$$
  $C$   $C^{(CH_2)_a}$   $C^{(CH_2)_b}$  where  $Z^1$  is a bond and a is 0 or 1;

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CF<sub>3</sub>.

-123-X<sup>5</sup> and X<sup>5a</sup> are each independently hydrogen, triffuoromothyl phacyl or entigodly substituted (C.-Ca)alkult  $-S(U)_{m}(U_{1}-U_{6})$ alkyl,  $-N(X^{2})(X^{2})$  or  $-U(U)N(X^{2})(X^{2})$ ; or  $X^5$  and  $R^7$  are taken together to form a  $(C_1-C_5)$ alkylene bridge. the Grade of the D3 is salected from the aroun consisting of 1 in this 1011-20 indolvi-CH2-23-ind 101 CH - phonylic c lalkyl-, 2-nyridelic communication communication and 4. (C<sub>1</sub>-C<sub>4</sub>)alkyl-, phenyl-CH<sub>2</sub>-S-CH<sub>2</sub>-, thienyl-(C<sub>1</sub>-C<sub>4</sub>)alkyl-, phenyl-(C<sub>0</sub>-C<sub>3</sub>)alkyl-O-CH<sub>2</sub>-. phenyl-CH2-O-phenyl-CH2- and 3-henzothienvl-CH2-; yl portion(s) of the efficient of the enable substituted with one to three substituents, each substituent being independently selected from the group consisting of methylenedioxy, 7, Ct. CH<sub>3</sub>, OCH<sub>3</sub>, OCF<sub>3</sub>, OCF<sub>2</sub>H and CF<sub>3</sub>. A compound according to claim 3 wherein R⁴ is hydrogen; a is O: n is 1 or 2: w is 0 or 1;  $X^5$  and  $X^{5a}$  are each independently, hydrogen, methyl or hydroxymethyl, provided that when  $X^5$  is hydrogen then  $X^{5a}$  is not hydrogen; R<sup>7</sup> and R<sup>8</sup> are each hydrogen; and  $R^3$  is phanyl-CH<sub>2</sub>-O-CH<sub>2</sub>-, phanyl-CH<sub>2</sub>-CH<sub>2</sub>-, 1 page H yl CH<sub>2</sub> , 2 page H J1 CH<sub>2</sub> , phenyl-(CH<sub>2</sub>)<sub>3</sub>- or 3-indolyl-CH<sub>2</sub>-; Where the 19th parties of the groups of for the 12th 12th is the 19th to the with one to three substituents, each substituent being independently selected from the group consisting of fluoro, chloro, methyl, OCH3, OCF2H, OCF3 and

5. A compound according to claim 4 wherein  $R^1$  is  $-(CH_2)_t - A^1$ ,  $-(CH_2)_0 - (C_3 - C_7)$  cycloalkyl or  $(C_1 - C_{10})$  alkyl;

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where  $A^1$  in the definition of  $R^1$  is optionally substituted with one to three things in the standard from the around the substitution of  $A^1$  in the definition of  $A^2$  is optionally substituted with one to three the standard from the around the substitution of  $A^1$  in the substitution of  $A^2$  in the substitution of  $A^2$  with  $A^2$  with  $A^2$  alkyl, hydroxyl,  $A^2$  alkoyy, carboxyl,  $A^2$  alkyl,  $A^2$  alkyl,  $A^2$  alkyl ester, 1H-tetrazol-5-yl or 1 to 3 fluoro;

Copelkyl group is optionary countries of with hydromy to the contribution of hologon

b. A compound according to maintermed the 100 and n° 1.

The recompound according to the 100 of 0; n° n° 1.

## $R^{1}$ is -(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup>;

pyrimidy) which is optionally substituted a literate this rely consisting of F, CI, Me, OMe,  $CF_3$ ,  $OCF_3$  and  $OCF_2(1)$  t is 0, 1 or 2;

and  $R^3$  is phenyl- $CH_2$ -O- $CH_2$ -, phenyl- $(CH_2)_3$ - or 3 indolyl  $CH_2$ -, where the anyl-portion is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Ma, CMa,  $CF_3$ ,  $CCF_3$  and  $CCF_2H$ .

- 8. A compound according to claim 7 wherein  $X^5$  and  $X^{5a}$  are each methyl;  $R^1$  is  $-CH_2$ -phenyl,  $-CH_2$ -4-fluoro-phenyl,  $-CH_2$ -pyridyl or  $-CH_2$ -thiazolyl and  $R^2$  is hydrogen, methyl, ethyl, t-butyl or  $-CH_2CF_3$ .
- 9. A compound adecrating to claim 8 wherein  $\mathbb{R}^{1} \subset \mathbb{R}^{2}$  , hence and  $\mathbb{R}^{3}$  in priority (Orligis).
- 10. The diaptersomeric mixture of a compound according to claim 0 where said compound is 2-amino 11 [1/(cu (c.,c)-bs.izyl-2-methyl-3-// methyl-3-// me
- 11. The compound according to claim 10 where the compound is 2-amino-N-[1-(3a-(R)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo-[4,3-c]pyridin -5-carbonyl)-4-phenyl-(R)-butyl]-isobutyramide.

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12. The compound according to claim 10 where the compound is 2-amino-N-[1-(3a-(S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo-[4,3-ddine-5-cart order and according to claim 10 where the compound is 2-amino-N-[1-(3a-(S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo-[4,3-ddine-5-cart order and according to claim 10 where the compound is 2-amino-N-[1-(3a-(S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo-[4,3-ddine-5-cart order and according to claim 10 where the compound is 2-amino-N-[1-(3a-(S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo-[4,3-ddine-5-cart order and according to claim 10 where the compound is 2-amino-N-[1-(3a-(S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo-[4,3-ddine-5-cart order and according to claim 10 where the compound is 2-amino-N-[1-(3a-(S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo-[4,3-ddine-5-cart order and according to acc

4-fluoro-phenyl and R<sup>3</sup> is 3-indolyl-CH<sub>2</sub>-.

- 14. The diastereometric mixture of a compound according to claim 13
- c]pyridin-5-yl)-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyl]-isobutyramide.
  - 16. The compound according to claim 14 where the compound in 2-amino-bl (\*\*) benzyl-2-metnyl-3-b (\*\*) 2,0,00, (\*\*)/-nexanyuro-pyrazolo-[4,3-c]pyridin-5-yl)-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyl]-isobutyramide.
  - 17. The diastereomeric mixture of a compound according to claim 12 where said compound is 2-amino-N-[2-(3a-(R,S)-benzyl-2-ethyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(P)-(1H-indol 3-ylmethyl)-2-oxo-ethyl]-isobutyramide.
  - 18. The compound according to claim 17 where the compound is 2-amino-N-[2-(3a-(R)-benzyl-2-ethyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-o]pyridin-5-yl)-1-(B)-(1H-indol-3-ylmothyl) 2 oxo ethyl] isobutyromi to
  - 19. The compound according to claim 17 where the compound is 2-amino-N-[2-(3a-(S)-benzyl-2-ethyl-3-oxo-2,3,3a,4,6,7 hexahydro-pyrazoto[4,3-c]pyridin-5-yl)-1-(R)-(1H-in-tot-3-ylmethyl)-2-oxo-ethyl)-inch-finantite.

  - 21. The compound according to claim 20 where the compound is 2-amino-N-[2-[3a-(R)-(4-fluoro-benzyl)-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-1-(R)-(1H-indol-3-ylmethyl)-2-oxo-ethyl]-isobutyramide.

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- 24. The diastereomeric mixture of a compound according to claim 23 (22), using the claim 23 hexahydro-pyrazoio[4,5-c<sub>1</sub>pytidiii-b-y<sub>1</sub>)- representations and substitutions.
- c.i.iii.o-iv-ia-i(0.) (ii) i.u. j. 2-methy! 1 u.u. z., i.d. iii. iii rahydro py c.]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide.

amino-N-[2-(3a-(R)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydru pyrazolo-[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl] isobutyromida L to taric acid salt.

- 27. The compound according to claim 24 where the compound is 2 amino-N-[2-(3a-(S)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo-[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide.
- 28. The diastereomeric mixture of a compound according to claim 23 where said compound is 2-amino N [2-(3a (13,0) benzyl-2-ethyl 2 exp 3,0,0+,1,0,7 hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-exp-ethyl]-isobutyramide.
- 29. The compound according to claim 28 where the compound is 2-amino-N-[2-(3a-(R)-benzyl-2-ethyl-3-oxo-2,3,3a,1,0,7-hexaliydro-py accito[1,3-0,5].idin-5-yl)-1-(R) benzyl-2-ethyl-3-oxo-2,3,3a,1,0,7-hexaliydro-py accito[1,3-0,5].idin-5-yl)-1-(R) benzyl-2-ethyl-3-oxo-2,3,3a,1,0,7-hexaliydro-py accito[1,3-0,5].idin-5-yl)-1-(R) benzyl-2-ethyl-3-oxo-2,3,3a,1,0,7-hexaliydro-py accito[1,3-0,5].idin-5-yl)-1-(R) benzyl-2-ethyl-3-oxo-2,3,3a,1,0,7-hexaliydro-py accito[1,3-0,5].idin-5-yl]-1-(R) benzyl-2-ethyl-3-oxo-2,3,3a,1,0,7-hexaliydro-py accito[1,3-0,5].idin-5-yl-3-idin-5-
- amino-N-[2-(3a-(S)-benzyl-2-ethyl-3-oxo-2,3,3a,4,3,7-th xahydro-pyrazolo[4,3-epyridiracly, artifactory, artif
- 31. The diastereomeric mixture of a compound according to claim 23 where said compound is 2-amino-N-{2-[3a-(R,S)-benzyl-3-oxo-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-1-(R)-benzyloxymethyl-2-oxo-ethyl)-isobutyramide.

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- 32. The compound according to claim 31 where the compound is 2-amino-N-{2-/3a-(R)-benzyl-3-oxo-2 (2.2.2-trifluoro athyl)-2.3.3a.4.6.7 benzyl-3-oxo-2 (2.2.2-trifluoro athyl)-2
- - amino-N-(1-(R)-benzyloxymethyl-2-[3a-(R)-(4-fluoro-benzyl)-2-methyl-3 dzg-
  - amino-N-(1-(R)-benzyloxymethyl-2-[3a-(G)-(4-firoro bonnyl)-2-methyl-3-oxu-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-o]pyridin-5-vil 2-oxo-ethyl}-isobutyramide.
    - 37. The diastereomeric mixture of a compound according to claim 23 where said compound is 2-amino-N-[2-(3a-(R,S)-benzyl-2-tert-butyl-3-oxo-2,3,3a,4,6,7-bexahydro-pyrazolo[4,3-c]pyridin 5 ylly-1-(R)-benzyloxymethyl 2 cynethylly ischutyramide.
    - 38. The compound according to claim 37 where the compound is 2-amino-N-[2-(3a-(R)-benzyl-2-tert-butyl-3-oxo-2,3,3a,4,6,7-hexahydra pyrazolo[4,3 c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2 oxo ethyl] inabutyramide.
    - The compound according to claim 37 where the constraint in 2-samino-N-[2-(3a-(S)-benzyl 2-tart-butyl-3-oxo-2,3,35 1,0,7 her shydro-buto-satisfa 0-satisfa (4.0) has sharp at the constraint of t
    - 40. A compound according to claim 5 vif. If in a is 1; m is 1; m is 1;  $R^{1}$  is L(M, N-N).

where A<sup>1</sup> in the definition of R<sup>1</sup> is phonyl, thienyl, thiazolyl, pyridyl or pyrimidyl which is optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, Cl, Me, OMe, CF<sub>3</sub>, OCF<sub>3</sub> and OCF<sub>2</sub>H; t is 0, 1 or 2;

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and R<sup>3</sup> is phenyl-CH<sub>2</sub>-O-CH<sub>2</sub>-, phenyl-(CH<sub>2</sub>)<sub>3</sub>- or 3-indolyl-CH<sub>2</sub>-, where the aryles of Colonial According to the second of the second

where said compound is z-amino-iv [2] (3a (R,G)-being) 3 exe-2,0,02, (,0,7-hexaliyare pyrazologik, a olygicallin 5-yl)-1 (iii) biologik, a chekk-? oxe-eth, jiii inchutyronide.

- 43. A compound according to claim 42 where the compound is 2 amino-
- 44. A compound according to claim 42 where the compound is 2-amino-N-[2-(3a-(S)-benzyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-1-(R)-benzyloxymethyl-2-oxo-ethyl]-isobutyramide.
- 45. A method for increasing levels of endogenous growth hormone in a human or other animal which comprises administering to such human or animal an effective amount of a compound of claim 1.
- 46. A pharmaceutical composition useful for increasing the endogenous production or release of growth hormone in a human or other animal which comprises an inert carrier and an effective amount of a compound of almin 1.
- 47. A pharmoceedical composition due full for increasing the enderging in the condense of the condense of the composition between the object of the composition and increase of the composition of the comp
- 48. A method for treating or preventing osteoporosis which comprises administering to a human or other animal in need of such treatment or prevention an amount of a compound of claim 1 which is effective in treating or preventing osteoporosis.

- 49. A method for treating or preventing diseases or conditions which may be high a prevented by growth there are a high comprises addition to be a second in need of the comprises addition to be a second in need of the comprises.
- 5 harmann

- A method according to the 149 y horsing the disease and addition in the bid response after a major operation, reducing careboxin and part in lose due to the 180 major, posterior was major surjusted to the 180 matter a major undergone major surjust. The method comprises administering to a mammal in need of such treatment an amount of a compound of the 34 triab is effective.
- thickness, metabolic homeostasis or renal homeostasis, which is all comprises administering to a human or other animal in need of such treatment an amount of a compound of claim 1 which is effective in promoting release of endogenous growth hormone.
  - 53. A method for the treatment or prevention of catue, creals which comprises administering to a human or other animal with osteoporosis a combination of a bisphosphonate compound and a compound of claim 1.
  - 51. A method for the tractor of of octooperatio contribute of in 52 wherein the hisphosphonate compound in the tractor to gate.
  - 55. A method for the treatment or prevention of ostpaparosis which comprises administering to a human or other animal with establishments a combination of the comprises of the combination of the combinat
    - R<sup>3</sup> is selected from the group consisting of 1-indolyl-CH<sub>2</sub>-, 2-indolyl-CH<sub>2</sub>-, 3-indolyl-CH<sub>2</sub>-, 1-naphthyl-CH<sub>2</sub>-, 2-naphthyl-CH<sub>2</sub>-, 1-benzimidazolyl-CH<sub>2</sub>-, 2-benzimidazolyl-CH<sub>2</sub>-, phenyl-(C<sub>1</sub>-C<sub>4</sub>)alkyl-, 2-pyridyl-(C<sub>1</sub>-C<sub>4</sub>)alkyl-, 3-pyridyl-(C<sub>1</sub>-C<sub>4</sub>)alkyl-, 4-pyridyl-(C<sub>1</sub>-C<sub>4</sub>)alkyl-, phenyl-CH<sub>2</sub>-S-CH<sub>2</sub>-, thi nyl-(C<sub>1</sub>-C<sub>4</sub>)alkyl-, phenyl-(C<sub>0</sub>-C<sub>3</sub>)alkyl-O-CH<sub>2</sub>-,

phenyl-CH<sub>2</sub>-O-phenyl-CH<sub>2-</sub>, 3-benzettlenyl-CH<sub>2-</sub>, thlenyl CH<sub>2</sub>-O CH<sub>2-</sub>, thinsely! CH<sub>2</sub>-

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July 1986 Control Control Control duffilent in 40F-1 which compiles advice using to a transmitte other action on IGF-1 deficiency a compound of claim 1.

estroyen agonist or antagonist and a compound of claim 1. 15

- A method according to claim 59 wherein the estrogen aganist or 60. antagonist is tamoxifen, droloxifene, raloxifene or idexifene.
  - 61. A compound of the formula

$$O \xrightarrow{(CH_2)_e} (CH_2)_n \xrightarrow{NH} \\ R^2 \qquad N$$

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n and ware each independently 0, 1 or 2, provided that wand nigaring both he 0 of

the same time; 25

 $R^{1} \ \ \text{is hydrogen, -CN, -(CH_{2})_{q}N(X^{6})C(O)X^{6}, -(CH_{2})_{q}N(X^{6})C(O)(CH_{2})_{l}-A^{1},}$  $-(CH_2)_qN(X^6)SO_2(CH_2)_t-A^1, \ -(CH_2)_qN(X^6)SO_2X^6, \ -(CH_2)_qN(X^6)C(O)N(X^6)(CH_2)_t-A^1, \ -(CH_2)_qN(X^6)SO_2X^6, \ -(CH_2)_qN(X^6)SO_2X^6, \ -(CH_2)_qN(X^6)C(O)N(X^6)(CH_2)_t-A^1, \ -(CH_2)_qN(X^6)SO_2X^6, \ -(CH_2)_qN(X^6)SO_2X^6, \ -(CH_2)_qN(X^6)C(O)N(X^6)(CH_2)_t-A^1, \ -(CH_2)_qN(X^6)SO_2X^6, \ -($  $-(CH_2)_qN(X^6)C(O)N(X^6)(X^6), \ -(CH_2)_qC(O)N(X^6)(X^6), \ -(CH_2)_qC(O)N(X^6)(CH_2)_t-A^1,$ 

-(CH-)\_C(O)OX6, -(CH<sub>2</sub>)\_C(O)O(CH)\_ ^1, (CH)\_QOX6, -(CH\_2)\_COCON(X6,0X6,

 $-(CH_2)_q - Y^1 - (CH_2)_1 - A^1 \text{ or } -(CH_2)_2 - Y^1 - (CH_2)_3 - Y^1 - Y^1$ 

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to 3 fluoro, 1 or 2 ( $C_1$ - $C_4$ )alkyl, hydraxyl, ( $C_1$ - $C_4$ )alkoxy, carbo  $y_1$ , -CINH<sub>2</sub>, -S(O)<sub>m</sub>( $C_1$ - $C_6$ )alkyl, -CO<sub>2</sub>( $C_1$ - $C_4$ )nlkyl onter, or 1H tetratul  $f_1y_1$ ;  $R^2 \text{ is hydrogen, } (C_1$ - $C_6$ )alkyl, -( $C_0$ - $C_3$ )alkyl-( $C_3$   $C_6$ )cycloclkyl, -( $C_1$ - $C_4$ )alkyl  $A^1$  or  $A^1$ ;

where the alkyl groups and the cycloalkyl groups in the definition of  $\mathbb{R}^2$  are optionally substituted by hydroxyl,  $-C(O)OX^6$ ,  $-C(O)N(X^6)(X^6)$ ,  $-N(X^6)(X^6)$ ,  $-S(O)_m(C_1-C_6)$  alkyl,  $-C(O)A^1$ ,  $-C(O)(X^6)$ ,  $CF_3$ , CN or 1 to 3 halogen;

 $A^1$  for each occurrence is independently ( $C_5$ - $C_7$ )cycloalkenyl, phenyl or a partially contrated, fully saturated or fill, we illusted 4- to 8 mass and a lepton by having 1 to 4 heteroatoms independently selected from the group consisting of oxygen, sulfur and nitrogen, or a Licyclic ring system consisting of a partially saturated fully unsaturated or fully saturated 5- or 8 members 1-11 or 10 mells in the partial oxygen, fused to A and A are the partial partially saturated.

unsaturated 5- or 6-membered ring, optionally having 1 to 4 heteroatoms independently selected from the group consisting of ninogen, sulfur and oxygon,

A<sup>1</sup> for each occurrence is independently optionally substituted, in one or optionally both rings if A<sup>1</sup> is a bicyclic ring system, with up to three substituents, each substituent independently selected from the group consisting of F, Cl, Br, I, OCF<sub>3</sub>, OCF<sub>2</sub>H, CF<sub>3</sub>, CH<sub>3</sub>, OCH<sub>3</sub>, -OX<sup>6</sup>,

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                                                                 Vincia 201 is lightly just or optionary a distribution of a distribution
                                                                                         the optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl defined for X<sup>11</sup> is
                                                                                         optionally independently substituted with promy, phenoxy, (C)-
IU
                                                                                         C_6)alkoxycarbonyl, -S(O)_m(C_1-C_6)alkyl, 1 to 5 halogens, 1 to 3
                                                                                         hydroxy, 1 to 3 (C_1-C_{10})alkanoyloxy or 1 to 3 (C_1-C_6)alkoxy;
                                                                 X<sup>12</sup> is hydrogen, (C<sub>1</sub>-C<sub>6</sub>)alkyl, phenyl, thiazolyl, imidazolyl, furyl or
                                                                  المنافع المناو يعملنا والمناوي والواوا والماري
                                                                  substituted with one to three substituents independently selected from
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                                                                  the group consisting of Cl, F, CH<sub>3</sub>, OCH<sub>3</sub>, CCF<sub>3</sub> and CF<sub>3</sub>;
                                                                  or X<sup>11</sup> and X<sup>12</sup> are taken together to form -(CH<sub>2</sub>),-L<sup>1</sup>-(CH<sub>2</sub>);
                                                                                         L^1 is C(X^2)(X^2), O, S(O)_m or N(X^2);
                                                                                          r for each occurrence is independently 1, 2 or 3;
                    X2 for each occurrence is independently hydrogen, optionally substituted (C1-
 20
                    C_6)alkyl, or optionally substituted (C_3-C_7)cyclocalkyl, where the optionally substituted
                    (C1-C8) airly aria updemaily adoptioned (C3-C7) order 1,10 to 1,000 to 1,200 to
                    optionally independently substituted with -C(O)_m(C_1-C_6)alkyl, -C(O)CX^3, 1 to 5
                    halogens or 1 to 3 OX3;
                                                                                                Simple of the first of the company
  25
                                                                                     and the second second
                     Cajainst, (C2-Castidiogottates ainst, is onery experience ( ) 17, 1
                     C<sub>7</sub>)-halogenated cycloalkyl, where optionally substituted (C<sub>1</sub>-C<sub>6</sub>) alkyl and collinging
                     substituted (C3-C7)cycloalkyl in the up librar of X3 is optionally independently
                     substituted with hydroxyl, (C_1-C_4)alkoxyl, carboxyl, CONI I_2, -C(O)_m(O_1, C_6)ull., I_3
    30
                      -CO<sub>2</sub>(C<sub>1</sub>-C<sub>4</sub>)alkyl, 1H-tetrazol-5-yl or 1 or 2 (C<sub>1</sub>-C<sub>4</sub>)alkyl; or
                      where there are two X<sup>6</sup> groups on one atom and both X<sup>6</sup> are (C<sub>1</sub>-C<sub>6</sub>)alkyl, the two
                      (C1-C6)alkyl groups may be optionally joined and, together with the atom to which the
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PCT/IB96/01353

-133-

two  $X^6$  groups are attached, form a 4- to 0- membered ring optionally having exygen, sufficient  $NX^7$ .

To with the proving that

 $X^6$  and  $X^{12}$  council ha hydrogram when it is attached to C(O) or  $SO_2$  in the form when  $S^6$  in by  $C_1$  and  $C_2$  in part  $C_2$  in  $C_3$ 

## 62. A compound according to claim 61 wherein

10 wis 9 or 1;

n is 1:

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 $R^1$  is hydrogen, -(CH<sub>2</sub>)<sub>q</sub>-(C<sub>3</sub>-C<sub>7</sub>)cycloalkyl, -(CH<sub>2</sub>)<sub>t</sub>-A<sup>1</sup> or (C<sub>1</sub>-C<sub>1c</sub>)alkyl where the (C<sub>1</sub>-C<sub>1c</sub>)alkyl and (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl groups are optionally substituted with 1 to 3 fluore

independently selected from the graph sensisting of F, Cl, Ma, matter y, CF<sub>3</sub>, OCF<sub>3</sub>
and OCF<sub>2</sub>H;

 $R^2$  is hydrogen,  $(C_1-C_8)$ alkyl,  $(C_0|C_3)$ alkyl- $(C_3-C_7)$ cycloalkyl, phemil, or  $(C_1-C_3)$ alkyl-phenyl where the alkyl and phenyl groups are optionally substituted with 1 to 3 substituents independently selected from the group consisting of F, CF<sub>3</sub>, OH and methoxy.

- 63. A compound according to claim 62 wherein w is 1; e is 0;  $\mathbb{R}^1$  is  ${}^{-CU_1}$  model. CU2 thirds or  ${}^{-CU_2}$  being any substituents independently selected from the group consisting of fluctuand chlore; and  $\mathbb{R}^2$  is hydrogen, (C<sub>1</sub>-C<sub>4</sub>)alkyl or phenyl where the (C<sub>1</sub>-C<sub>4</sub>)alkyl or phenyl groups in the deficition of  $\mathbb{R}^2$  is collaborate substituted with the 2 substitute of  $\mathbb{R}^2$  is collaborate substituted with the 2 substitute of  $\mathbb{R}^2$ .
- is methyl or hydrogen.
- 65. A compound according to claim 11 wherein the compound is the Ca-30 (R) enantiomer.
  - 66. A compound according to claim 64 wherein the compound is the 3a-(S) enantiomer.
    - 67. A compound of the formula

wherein

5 Z<sup>100</sup> is methyl, BOC, CBZ, CF<sub>3</sub>C(O)-, FMOC, TROC, trityl, tosyl, CH<sub>3</sub>C(O)- or optionally substituted benzyl which is optionally substituted with methoxy, dimethoxy or nitro;

e is 0 or 1:

10 the same time;

$$\begin{split} & R^1 \quad \text{is hydrogen, -CN, -(CH_2)_qN(X^6)C(O)X}^5, -(CH_2)_qN(X^6)C(O)(CH_2)_t - A^1, \\ & -(CH_2)_qN(X^6)SO_2(CH_2)_t - A^1, -(CH_2)_qN(X^6)SO_2X^6, -(CH_2)_qN(X^6)C(O)N(X^6)(CH_2)_t - A^1, \\ & -(CH_2)_qN(X^6)C(O)N(X^6)(X^6), -(CH_2)_qC(O)N(X^6)(X^6), -(CH_2)_qC(O)N(X^6)(CH_2)_t - A^1, \\ & -(CH_2)_qC(O)OX^6, -(CH_2)_qC(O)O(CH_2)_t - A^1, -(CH_2)_qOX^6, -(CH_2)_qOC(C)X^6, \\ \end{split}$$

 $\begin{array}{ll} -(CH_2)_q OC(O)(CH_2)_t - A^1, \ -(CH_2)_q OC(O)N(X^6)(CH_2)_t - A^1, \ -(CH_2)_q OC(O)N(X^6)(X^5), \\ -(CH_2)_q C(O)X^6, \ -(CH_2)_q C(O)(CH_2)_t - A^1, \ -(CH_2)_q N(X^6)C(O)OX^6, \\ -(CH_2)_q N(X^6)SO_2 N(X^6)(X^6), \ -(CH_2)_q S(O)_m X^6, \ -(CH_2)_q S(O)_m (CH_2)_t - A^1, \\ -(C_1 - C_{10})aikyl, \ -(CH_2)_t - A^1, \ -(CH_2)_q - (C_3 - C_7)cycloaikyl, \ -(CH_2)_q - r^1 - (C_1 - C_6)aikyl, \\ -(CH_2)_q - Y^1 - (CH_2)_t - A^1 \ or \ -(CH_2)_q - Y^1 - (CH_2)_t - C_7)cycloaikyl, \end{array}$ 

q is 0, 1, 2, **3 or 4**;

t is 0, 1, 2 or 3;

said  $(CH_2)_q$  group and  $(CH_2)_1$  group may each be optionally substituted with hydroxyl,  $(C_1-C_4)$ alkoxy, carboxyl,  $-CONH_2$ ,  $-S(O)_m(C_1-C_6)$ alkyl,

```
-CO<sub>2</sub>(C<sub>1</sub>-C<sub>4</sub>)alkyl, 1H-tetrazol-5-yl, 1 to 3 fluoro or 1 or 2 (C<sub>1</sub>-C<sub>4</sub>)alkyl;
           R2 is hydrogen, (Ct-Ca)alkyl, -(Ca-Ca)alkyl, (Ca-Ca)alkyl, (Ca-Ca)alkyl, -(Ct-Ca)alkyl, at an A1-
           where the alkyl groups and the cycloalkyl groups in the definition of \mathbb{R}^2 are optionally
                               with hold to generate a constitution of the co
           _croin | crowning ( ... 121) and to a halaman
           A<sup>1</sup> for each occurrence is independently (C<sub>5</sub> C<sub>7</sub>)cycloal(teny), (A 4.6) | A 1.7 (2.7 %)
                                                          il or fully a con-
           product the following and the construction of
           oxygen, sulfur and nitrogen, or a bicyclic ring system consisting of a partially
           saturated, fully unsaturated or fully saturated 5- or 6-membered ring, optionally
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            having 1 to 4 heteroatoms independently selected from the group consisting of
            nitrogen, sulfur and oxygen, fused to a partially saturated, fully saturated or fully
            constructed 5. or 6 marchaned discontinuous books of the different and
            independently selected from the group consisting of nitrogen, sulfur and oxygon,
                          A<sup>1</sup> for each occurrence is independently optionally substituted, in the or
15
                          ontionally both rings if A1 is a biqualia ring cystem, with up to these
                          substituents, each substituent independently astocked from the group
                          consisting of F. Cl. Br. I. OCF<sub>3</sub>, OCF<sub>2</sub>H, CF<sub>3</sub>, CH<sub>3</sub>, OCH<sub>3</sub>, -OX<sup>6</sup>,
                          -C(O)N(X^6)(X^6), -C(O)OX^6, oxo, (C_1, C_6)alkyl, nitro, cyano, benzyl,
                          -S(O)<sub>m</sub>(C<sub>1</sub>-C<sub>6</sub>)alkyl, 1H-tetrazol-5-yl, phenyl, phenoxy, phenyl-thylom,
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                          halophenyl, methylenedioxy, -N(X^6)(X^6), -M(X^6)C(O)(X^5), -SO_2N(X^6)(Y^6)
                          -N(X6)SO2 phanyl, -N(X6)SO, X6, -OCT X11X12, CO,NX11X13, T1X6CO, Y12,
                          -NX6CONX11X12 -NX6SO<sub>2</sub>NX11X12 -NX6C(O)X12 imidizately thiazoly and
                          totropolyl, provided that if \Lambda^{1} is off-nally constituted with methyl and floxy
                          then it can only be substituted with one methylenedioxy:
25
                                                                                           antienally a better the terror of the
                                                                  optionally substituted (1), James 15 med 14 X<sup>11</sup> to
                                                        optionally independently substituted with phonyl, pheroxy, (C<sub>1</sub>-
                                                        C_6)alkoxycarbonyl, -S(O)_m(C_1-C_6)alkyl, 1 to 5 halogens, 1 to 3
                                                        hydroxy, 1 to 3 (C_1-C_{10})alkanoyloxy or 1 to 3 (C_1-C_6)alkoxy;
30
                                         X<sup>12</sup> is hydrogen, (C<sub>1</sub>-C<sub>6</sub>)alkyl, phenyl, thiazolyl, imidazolyl, furyl or
                                         thienvl, provided that when X12 is not hydrogen, X12 is optionally
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substituted with one to three substituents independently selected from  $0.03 \pm 0.03$  or  $X^{11}$  and  $X^{12}$  are taken together to form  $-(CH_2)_r-L^3-(CH_2)_r$ :

You for each occurrence is income the result of the control of

No for each occurrence is independently by a few or the first of

 $(C_1-C_6)$ alkyl and optionally substituted  $(C_3-C_1)$ -yelloalkyl in the formula  $(C_1-C_6)$ -alkyl and optionally substituted  $(C_3-C_1)$ -yelloalkyl independently substituted  $(C_3-C_1)$ -yelloalkyl in the following substitut

X<sup>3</sup> for each occurrence is independently hydrogen or (C<sub>1</sub>-C<sub>6</sub>)alkyl;

 $X^6$  for each occurrence is independently hydrogen, optionally substituted (C  $_i$ -

C<sub>7</sub>)-halogenatedcycloalkyl, where optionally obsolitated (C<sub>1</sub>-C<sub>6</sub>)alkyl and a line y substituted (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl in the definition of X<sup>5</sup> is optionally independently substituted with hydroxyl, (C<sub>1</sub> C<sub>4</sub>)alkoxy, includy, (C included C<sub>1</sub> C<sub>6</sub>)alkyl, 1H-tetrazol-5-yl or 1 or 2 (C<sub>1</sub> C<sub>4</sub>)alkyl, 0. where there are two X<sup>6</sup> groups on one atom and both X<sup>6</sup> and (C<sub>1</sub> C<sub>6</sub>)alkyl groups may be optionally joined and, together with the atom to which the two X<sup>6</sup> groups are attached, form a relicious consecutions operating operation.

K<sup>2</sup> is hydrogen or (C<sub>1</sub>-C<sub>6</sub>)aikyl optionally substituted with hydroxyl, air inforeach occurrence is independently 0, 1 or 2;

with the proviso that:

25 X<sup>6</sup> and X<sup>12</sup> carmot be hydrogen when it is attached to O(0) or O(1) in the first

when  $R^2$  is H and  $R^4$  is -CH<sub>2</sub>-CH=CH in , the  $t^{100}$  is not BOC;

when R<sup>2</sup> is H and R<sup>1</sup> is then Z<sup>100</sup> is not BOC;

- 30 when  $R^2$  is H and  $R^1$  is  $-CH_2-C(CH_3)=CH_2$ , then  $Z^{100}$  is not BOC; and when  $R^2$  is phenyl and  $R^1$  is  $-CH_3$ , then  $Z^{100}$  is not  $CH_3C(O)$ -.
  - 68. A compound according to claim 67 wherein w is 0 or 1;

n is 1;

7100 is BOC methyl benzul or CB7.

R<sup>3</sup> is hydrogen, -(CH<sub>2</sub>)<sub>q</sub>-(O<sub>3</sub> O<sub>7</sub>)<sub>Q</sub>ydodl(y), -(CH<sub>2</sub>)<sub>q</sub>-(O<sub>3</sub> O<sub>7</sub>)<sub>Q</sub>ydodl(y), -(CH<sub>2</sub>)<sub>q</sub>-(O<sub>3</sub> O<sub>7</sub>)<sub>Q</sub>ydodl(y), -(CH<sub>2</sub>)<sub>q</sub>-(O<sub>3</sub> O<sub>7</sub>)<sub>Q</sub>ydodl(y), conjugate optimally and characteristic optimal  $A^{1}$  in the definition of R<sup>1</sup> is optionally substituted with 1 to 3 substituted independently polarized from the argument  $A^{1}$  in  $A^{2}$   $A^{2}$   $A^{3}$   $A^$ 

phenyl where the alkyl and phenyl groups are ontinedly substituted with 1 to 3 substituents independently selected from the group pursuisating of  $\Gamma_1$  and  $\Gamma_2$  and  $\Gamma_3$  and  $\Gamma_4$  and  $\Gamma_5$  are consisting of  $\Gamma_4$  and  $\Gamma_5$  and  $\Gamma_6$  and  $\Gamma_6$  are consisting of  $\Gamma_5$  and  $\Gamma_6$  and  $\Gamma_6$  are consisting of  $\Gamma_6$  and  $\Gamma_6$  are consisting of  $\Gamma_6$  and  $\Gamma_6$  and  $\Gamma_6$  are consisting of  $\Gamma_6$  and  $\Gamma_6$  are consistent and  $\Gamma_6$  and  $\Gamma_6$  are consistent and  $\Gamma_6$  are consistent and  $\Gamma_6$  are consistent and  $\Gamma_6$  and  $\Gamma_6$  are consistent and  $\Gamma_6$ 

- 69. A compound according to claim 68 wherein Z<sup>100</sup> is BOC; w is 1; e is 0; an according to the control of the c
  - 70. A compound according to claim 69 wherein  $\mathbb{R}^1$  is -CH<sub>2</sub>-phenyl and  $\mathbb{R}^2$  is methyl or hydrogen.
  - 71. A compound according to claim 70 is boroin the compound in the 2 is (R) enantiomer.
    - (S) enantiomer.
      - 73. A compound of the formula

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the racemic-diastereomeric mixtures and optical isomers of said compounds,
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Z<sup>200</sup> is t-BOC, CBZ, CF<sub>3</sub>C(O)-, FMOC, TROC, trityl, tosyl or optionally substituted benzyl which is optionally substituted with memoxy, dimediaxy or nitro;

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 $R^{1} \text{ is hydrogen, -CN, -(CH_{2})_{q}N(X^{6})C(O)X^{6}, -(CH_{2})_{q}N(X^{6})C(O)(CH_{2})_{t}-A^{1},} \\ -(CH_{2})_{q}N(X^{6})CO_{2}(CH_{2})_{t}-A^{1}, -(CH_{2})_{q}N(X^{6})CO_{2}(CH_{2})_{q}CO_{2}(CH_{2})_$ 

 $\begin{array}{l} -(C_{12})_q C(C)_{1} C(C)_{2} C(C)_{1} C(C)_{2} C(C)_{1} C(C)_{2} C(C)_{1} C(C)_{2} C$ 

where the alkyl and cycloalkyl groups in the definition of  $R^1$  are optionally substituted with  $(C_1-C_4)$ alkyl, hydroxyl,  $(C_1-C_4)$ alkoxy, carboxyl,  $CC^{1+4}_{2,1}$   $-S(O)_m(C_1-C_6)$ alkyl,  $-CC_2(C_1-C_4)$ alkyl ester, 111 ...l/(a-1.5-)1 or 1 to 3 fluoro;

 $Y^{1}$  is O, S(O)<sub>m</sub>, -C(O)NX<sup>5</sup>, -CH=CH-, -C=C-, -N(X<sup>5</sup>)C(O), -C(O)H<sup>2</sup>/<sub>2</sub>, -C(O)O, -CC(O)H<sup>2</sup>/<sub>2</sub>,

q is 0, 1, 2, 3 or 4;

t is 0, 1, 2 or 3;

said  $(CH_2)_4$  group and  $(CH_2)_1$  group may each be antiopally substituted with  $(CH_2)_4$   $(CH_2)_6$   $(CH_2)_6$  (CH

 $-CO_2(C_1-C_4)$ alkyl, 1H-tetrazol-5-yl, 1 to 3 fluoro or 1 or 2  $(C_1-C_4)$ alkyl,

 $R^2$  is 1 jetrogen,  $(C_1-C_8)$ alkyl,  $-(C_0-C_0)^{-1/2}$   $(C_3-C_8)$ sycloallo $(C_3-$ 

where the alkyl groups and the cycloalkyl groups in the definition of  $\mathbb{R}^2$  are optionally substituted with hydroxyl,  $-C(O)OX^6$ ,  $-C(O)N(X^6)(X^6)$ ,  $-N(X^6)(X^6)$ ,  $-S(O)_m(C_1-C_6)alkyl$ ,  $-C(O)A^1$ ,  $-C(O)(X^6)$ ,  $CF_3$ , CN or 1 to 3 halogen;

 $\begin{array}{l} R^3 \text{ is } A^1, \ (C_1 - C_{10}) \\ \text{alkyl.} \ - (C_1 - C_6) \\ \text{alkyl-} A^1, \ - (C_1 - C_6) \\ \text{alkyl-} X^1 - (C_1 - C_5) \\ \text{alkyl-} X^1 - (C_1 - C_5) \\ \text{alkyl-} X^1 - (C_0 -$ 

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$$-(C_1-C_5)$$
alkyl- $X^1-(C_1-C_5)$ alkyl- $(C_3-C_7)$ cyclopikyl;

where the alkyl groups in the definition of  $\mathbb{P}^3$  is obtionally substituted with  $-S(O)_m(O_1|O_6)$  alkyl,  $-C(O)OX^2$ , 1 to  $S(C)^2$   $(O,C)^2$  (O,C) (

5  $-N(X^2)C(O)O_{-}$ ,  $-OC(O)N(X^2)_{-}$  or  $-C=C_{-}$ ;

Carbon and the Mile of the Area of the Company of t

1 to 4 heteroatoms independently selected from the group consisting of exygen, a transfer of the partial configuration of the partial configuration of the selected field selected field to a partially seturated field in selected field or fully saturated 5- or 6-membered ring, optionally having 1 to 4 heteroatems.

in a supplier of the control of the property of the control of the

to which  $X^4$  is attential and the carbon of x to which  $\mathbb{R}^4$  in attential or if for the  $\mathbb{R}^4$  decreases the radial x

where a and b are independently 0, 1, 2 or 3;

 $X^5$  and  $X^{5a}$  are each independently selected from the group consisting of hydrogen, tritluoromethyl,  $A^1$  and optionally substituted  $(C_1-C_6)$ alkyl;

the optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl in the definition of  $X^5$  and  $X^{5a}$  is optionally substituted with a substituent selected from the group consisting of  $A^1$ ,  $-OX^2$ ,  $-S(U)_{m_1} \cup_{1} - \cup_{6} J \text{ and } J_1$ ,  $-C(O)OX^2$ ,  $(\cup_{3} - \cup_{7} J \cup_{$ 

or the carbon bearing  $X^5$  and  $X^{5a}$  forms an alkylene bridge with the nitrogen atom bearing  $Z^{200}$  and  $K^7$  where the alkylene bridge contains into 3 carbon atoms provided that  $X^5$  or  $X^{5a}$  but not both may be on the carbon atom and  $Z^{200}$  or  $R^8$  but not both may be on the nitrogen atom;

or X<sup>5</sup> is taken together with X<sup>5a</sup> and the carbon atom to which they are attached and form a partially saturated or fully saturated 3- to 7-membered

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ring, or a partially saturated or fully saturated 4- to 8 membered ring having 1

oxygen, suriur and nitrogen;

or  $X^5$  is taken together with  $X^{5a}$  and the carbon atom to which they are attached and form a bicyclic ring system consisting of a partially naturated or  $X^{5a}$ , rated  $S_7$  or  $S_7$ -member of the optionally natural of  $X^{5a}$  is taken together with  $X^{5a}$  and the carbon atom to which they are attached and form a bicyclic ring system consisting of a partially naturated or  $X^{5a}$ .

6-membered ring, optionally having 1 to 4 heteroatoms independency selected from the group consisting a minegan, pulfer and any and 2 is a purity of rest. 2, provided that there have a horizont of the N-X<sup>2</sup> or O:

where the optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl in the definition of  $\mathbb{R}^8$  is optionally independently substit 1. In this  $\mathbb{A}^1$ ,  $-\mathbb{C}(\mathbb{C})\mathbb{O}\cdot(\mathbb{C}_1\cap\mathbb{C})$  alkyl, 1 to 5 halogens, 1 to 3 hydrony, 1 to 2  $\mathbb{O}(\mathbb{C})\cdot(\mathbb{C}_1\cap\mathbb{C})$   $\mathbb{C}(\mathbb{C}_1^2-\mathbb{C}_6)$  alkoxy; or

A¹ for each occurrence is independently  $(C_5-C_7)$  cycloalkenyl, phanyl or a partially saturated, fully saturated or fully unsaturated 4- to 8-membered ring optionally having 1 to 4 heteroatoms independently selected from the group or spiriting of oxygen, sulfur and nitrogen, or a bicyclip ring system consisting of a partially unsaturated, fully unsaturated and independently selected from the group consisting of nitrogen, sulfur and oxygen, fused to a partially saturated, fully saturated or fully unsaturated 5- or 6-month-ord ring, optionally having 1 to 4 heteroatoms in the group consisting of nitrogen, sulfur and oxygen, fused to a partially having 1 to 4 heteroatoms in the group consisting of nitrogen, sulfur and oxygen;

A¹ for each occurrence is independently optionally substituted, in one or mally both rings if  $A^1$  is a binable ring system, with the three substituents, each substituent independently selected from the group consisting of F, Cl, Br, I, OCF<sub>3</sub>, OCF<sub>2</sub>H, CF<sub>3</sub>, CH<sub>3</sub>, OCH<sub>3</sub>,  $-OX^6$ ,  $-C(O)N(X^6)(X^6)$ ,  $-C(O)OX^6$ , oxo,  $(C_1-C_6)$ alkyl, nitro, cyano, benzyl,  $-S(O)_m(C_1-C_6)$ alkyl,  $-S(O)_m(C_1-C_6)$ alkyl, -S(O)

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 $-N(X^6)SO_2$ -phenyl,  $-N(X^6)SO_2X^6$ ,  $-CONX^{11}X^{12}$ ,  $-SO_2NX^{11}X^{12}$ ,  $-NX^6SO_2X^{12}$ ,

tetrazolyl, provided that if A<sup>1</sup> is optionally substituted with methylenedioxy then it can only be substituted with one methylenedioxy;

where  $X^{11}$  is hydronen or optionally substituted (C., C.) allows.

the positionally of the second of the second

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hydroxy, 1 to 3 (C<sub>1</sub>-C<sub>10</sub>)alkanoyloxy or 1 to 3 (C<sub>1</sub>-C<sub>6</sub>)alkoy;  $\times^{12}$  in hydrogen, (C<sub>1</sub>-C<sub>1</sub>), "all plans, then yell in hydrogen, (C<sub>1</sub>-C<sub>1</sub>), "all plans, then yell and hydrogen,  $\times^{12}$  in provided that when  $\times^{12}$  in a hydrogen,  $\times^{12}$  is all substituted with one to three substituents independently solubted from

or  $X^{11}$  and  $X^{12}$  are taken together to form  $-(CH_2)_t - L^1 - (CH_2)_{r-1}$ ;  $L^4$  is  $C(X^2)(X^2)_t$ ,  $O_t$ ,  $S(O)_m$  or  $N(X^2)_t$ :

pring and the grant in the mile that a so

 $X^2$  for each occurrence is independently hydrogen, optionally subclitated ( $C_1$ - $C_6$ )alkyl, or optionally substituted ( $C_3$ - $C_4$ )cyclitalkyl, where the options by subclitated ( $C_3$ - $C_6$ )alkyl and optionally substituted ( $C_3$ - $C_7$ )cyclonlkyl in the definition of  $X^2$  are optionally independently substituted with  $-S(O)_m(C_1$ - $C_6$ )alkyl,  $-C(O)OX^3$ , 1 to 5 halogens or 1 to 3  $-OX^3$ ;

was the first of the second of

 $X^6$  for each occurrence is independently hydrogen, optionally substituted (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>2</sub>-C<sub>6</sub>)halogenated alkyl, optionally substituted (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl, or (C<sub>3</sub>-C<sub>7</sub>)-halogenated cycloalkyl, where optionally substituted (C<sub>1</sub>-C<sub>5</sub>)alkyl and Eyally substituted (C<sub>3</sub>-C<sub>7</sub>)cycloalkyl in the definition of  $X^6$  is optionally independently substituted with hydroxyl, (C<sub>1</sub>-C<sub>4</sub>)alkoxy, carboxyl, CONH<sub>2</sub>, -S(O)<sub>m</sub>(C<sub>1</sub>-C<sub>6</sub>)alkyl,

-CO (C.C )alkal, 1H-tetrazol-5-yl or 1 . r 2 (C. C )alkal; or

when there are two  $X^6$  groups on one atom and both  $X^6$  are  $(C_1-C_6)$  alkyl, the two  $(C_1-C_6)$ 

 $C_6$ )alkyl groups may be optionally joined and, together with the atom to which the two  $X^6$  groups are attached, form a 4- to 9- membered ring optionally having oxygen, sulfur or  $NX^7$ :

X<sup>7</sup> is hydrogen or (C<sub>1</sub>-C<sub>6</sub>)alkyl optionally substituted by hydroxyl; and

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m for each occurrence is independently 0, 1 or 2;

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 $X^6$  and  $X^{12}$  cannot be hydrogen when it is attached to C(O) or  $SO_2$  in the form  $C(O)X^6$ ,  $C(O)X^{12}$ ,  $SO_2X^5$  or  $SO_2X^{12}$ ; and

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hydrogen; X' is nydrogen;  $R^6$  is  $-C(Cri_{3/2}; a_1^{-1})$  is above and  $R^6$  is hydrogen.

10. Accompatition according to a finite of the

K is riyurusan, als u, mis 1; Wis i, sis u,

X3 and X5a are each independently, hydrogen, methyl or hydroxymethyl, provided

RT end " are eaching . \_ di;

15 Y is oxygen;

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for is hydrogen, methyl, ethyl, propyl, inpropyl, thirtyl, noticers, and in appropriate cyclopropyl;

R1 is CH2-A1;

where  $A^{1}$  in the definition of  $R^{1}$  is phonyl, dibay!, thiszolyl, pyridyl and, and which is optionally substituted with one to three substituted, each substituent being independently selected from the group consisting of F. Cl. Me, OMe,  $CF_{0}$ ,  $COT_{0}$  and

R³ is phenyl-CH<sub>2</sub>-O-CH<sub>2</sub>-, phenyl-(CH<sub>2</sub>)<sub>3</sub>-, 3-indolyl-CH<sub>2</sub>-, thionyl-CH<sub>2</sub>-O-CH<sub>2</sub>, thiazolyl-CH<sub>2</sub>-O-CH<sub>2</sub>-, pyridyl-CH<sub>2</sub>-O-CH<sub>2</sub>-, pyridyl-CH<sub>2</sub>-O-CH<sub>2</sub>- or phonyl-O-CH<sub>2</sub>-CH<sub>2</sub>, where the anyl portion is  $c_1$ :  $c_1$ :  $c_2$ :  $c_3$ :  $c_4$ :  $c_4$ :  $c_4$ :  $c_5$ :  $c_5$ :  $c_6$ 

77. A compound according to doim 75

wherein X<sup>5</sup> and X<sup>5a</sup> are each methyl;

30 R<sup>2</sup> is methyl, ethyl, or -CH<sub>2</sub>CF<sub>3</sub>;

A<sup>1</sup> is phenyl optionally substituted with one to three substituents, each substituent being independently selected from the group consisting of F, CI, Me, OMe, CF<sub>3</sub>, OCF<sub>3</sub> and OCF<sub>2</sub>H;

 $R^3$  is phenyl- $CH_2$ -O- $CH_2$ -, phenyl- $(CH_2)_3$ - or thienyl- $CH_2$ -O- $CH_2$ - where the arylem of analysis shallows believe the distribution of the property of the proper

TT A composited according to claim TS

where the control of a purish and an incoming to claim TS

\*\*Transport of a purish and and an incoming to the control of the control

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profiles is optionally substituted with a to three substituents, each and office; it is an included on the decrep consisting of F, CI, Me, OMe, CF<sub>3</sub>, OCF<sub>3</sub> and COF<sub>2</sub>:

A Com, and and the start of

wherein X<sup>5</sup> and X<sup>5a</sup> are each methyl; R<sup>2</sup> is methyl, ethyl, or CH<sub>2</sub>OF<sub>2</sub>:

A<sup>1</sup> is plainyl optionally substituted with the substituents cash substituent being independently selected from the group consisting of F, Cl, Ma, CMa, CF<sub>2</sub>, OCF<sub>3</sub> and OCF<sub>2</sub>H; R<sup>3</sup> is 2-pyridyl-CH<sub>2</sub>-O-CH<sub>2</sub>-, or 3-pyridyl-CH<sub>2</sub>-O-CH<sub>2</sub>- where the aryl portion is optionally substituted with one to two substituents, each substituent being independently selected from the group consisting of F, Cl, Ma, CMa, CF<sub>3</sub>, OCF<sub>3</sub> and OCF<sub>2</sub>H.

79. A compound poparding to claim 77 having the formula

the racemic-diastereomeric mixtures and optical isomers of said compounds wherein  $\mathbb{R}^2$  is methyl;  $\mathbb{A}^1$  is 2-nyridyl; and  $\mathbb{R}^3$  is  $\mathbb{C}^4$ . O CH, obenyl;

R<sup>2</sup> is CH<sub>2</sub>CF<sub>3</sub>; A<sup>1</sup> is 2-pyridyl; and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-3-chloro-phenyl; R<sup>2</sup> is CH<sub>2</sub>CF<sub>3</sub>; A<sup>1</sup> is 2-pyridyl; and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-4-chloro-phenyl; R<sup>2</sup> is CH<sub>2</sub>CF<sub>3</sub>; A<sup>1</sup> is 2-pyridyl; and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-2,4-di-chloro-phenyl; R<sup>2</sup> is CH<sub>2</sub>CF<sub>3</sub>; A<sup>1</sup> is 2-pyridyl; and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-3-chloro-thiophene; or

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propionamide.

R<sup>2</sup> is CH<sub>2</sub>CF<sub>3</sub>; A<sup>1</sup> is 2-pyridyl; and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-2,4-di-fluoro-phenyl.

where the compound is 2-amino-N-[1-(R)-benzyloxymethyl-2-(1 mining) or to 0.5-(R,S)-pyridin-2-ylmethyl-2,3,3a,4,6,7-hexphydro-pyrazolo[4,3-c]pyridin-5-yl)-1 pxo-

2.3.3a.4.6.7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl)-2-oxo-ethyl-2-methyl-

where the compound is 2-amino-ik (1-(π)-(3-chloro-benzyloxymeth, t)-2-oxo-2 (3-oxo-ba-(π,υ)-μ) tidin-2-ylmothy, 2 (2,2,2 milliouro-eth), t)-2,3,23,4,6,7 here is pyrazolo(4,3-c pyridin-b-yrj-ethyr)-2 mothy, propionamics.

- 84. The compound according to claim 83 where the compound is 2-amino-N-(1-(R)-(3-chloro-benzyloxymethyl)-2-охо-2-[3-охо-3-(R)-pyridin-2-уч. 24 у/ 2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-с-]pyridin-5-y/) саметнуl-propionamide.
- 85. The compound according to claim 83 will. If the proof is 2-amino-N-(1-(R)-(3-chloro-benzyloxymethyl)-2-oxo-2-[3 oxo-3a (3) ; yiddin 2 ylmnthyl-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexhlydro pyrazolo[4,3-c ]pyridin 5 yll thyll 2-methyl proof is a proof in a proof in the proof is a proof in the proof in the proof is a proof in the proof in the proof is a proof in the proof in the proof in the proof is a proof in the proof in the proof in the proof is a proof in the proof in the proof in the proof in the proof is a proof in the proof in the proof in the proof in the proof is a proof in the p
- 86. The diastereomeric mixture of a compound according to cl. 1... 73 where the compound is 2-amino-N-{1-(R)-(4-chloro-benzyloxymethyl)-2-oxo-2-{3-oxo-3a-(R,S)-pyridin 2 ylmicthyl-2-(2,2,2-trifluoro-ethyl) 2,2,2a,4,6,7-hexabydro-pyrazolo[4,3-c]pyridin-5-yl]-ethyl}-2-methyl-propionamide.
- 87. The compound according to claim 86 where the compound is 2-amino-N-{1-(R)-(4-chloro-benzyloxymethyl)-2-oxo-2-[3-oxo-3a-(R)-pyridin-2-yl methyl-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-ethyl}-2-methyl-propionamide.

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-145-

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  The displacements mixture of a compound a social as to 3 a 70.

  The displacements mixture of a compound a social as to 3 a 70.
- 90. The compound according to claim 33 whors the compound is 2ylmathyl 3/3/3/3 tiffuoro-othyl)-2/3/3/4/5 The physical proposition of the compound is 2ethyl)-2-methyl-propionamide.
- The compound according to claim 80 where the core and the 0, and to 1 (1, (1), (2,4 arcticle mayiesymbolic), 2 and 2 (1, - -(S)-pyridin 2) ylmethyl-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexehydro-pyrazolo[4,3-c]pyridin-5 yi]-ethyl-2-methyl-propionamide.

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- vibere the compound is 2-amino-N (1 (7) (4-chloro thiophen 2-yla orbody) oxo-2-[3-oxo-2o (P,S)-pyridin-2-ylmethyl 2-(2,2,2-triff) orcosthyl)-2,3,3a,4,5,7-hexahydro-pyrazolo[3,4-o]pyridin-6-yl] othyl) 2 mothyl propiormide.
- 93. The compound according to claim 92 where the compound is 2-amino-M (4-(P) (4-at face thioption 2 ylmothory (24-)) 0 km 0 (2 amo 0 a (D) cyriclin-2 ylmothyl-2-(2,2,2-triffuor 1.8 b) 2,2,2-1,4,5,7 hrs. 1 at (0,4 c)pyridin-6-yll-ethyll-2-methyl-propional (1 a.
- 25 94. The compared according to claim 03 where the compared to 2 amino 11 (11 (1) (1 shlero-thiophen 0.) 1 (1) (1 thyl) 2 exc 0 (2 (1) (1) pyridin-2-ylmethyl-2-(2,2,2-trifluoro-ethyl) 2,0,0a,4,5,7-hexahydro pyruzzlu(0,1 c]pyridin-6-yl]-ethyl)-2-methyl-propionamide.
- 95. The diastereomeric mixture of a compound according to claim 79
  where the compound is 2-amino-N-{1-(R)-(2,4-difluoro-benzyloxymethyl)-2-oxo-2-[3-oxo-3a-(R,S)-pyridin-2-ylmethyl-2-(2,2,2-trifluoro-ethyl)-2,3,3a,4,6,7-hexahydro-pyrazolo[4,3-c]pyridin-5-yl]-ethyl}-2-methyl-propionamide.

-146-

96. The compound according to claim 95 where the compound is 2compositely, (a, resince of a composite of a co

e(nyi)-z-memyi-propromamioe.

98. A compound according to claim 8 having the formula

the racemic-diastereomeric mixture, and optical includes of a factor and analysis.

R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is methyl and R<sup>3</sup> is -(CH<sub>2</sub>)<sub>3</sub>-phenyl;

 $\mathbb{R}^1$  is -CH<sub>2</sub>-phenyl,  $\mathbb{R}^2$  is methyl and  $\mathbb{R}^3$  in 3-indel/tend<sub>2</sub>;

R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is ethyl and R<sup>3</sup> is 3-indolyl-CH<sub>2</sub>-;

 $\mathbb{R}^{1}$  is  $-CH_{2}$ -4-fluoro-phenyl,  $\mathbb{R}^{2}$  is now, and  $\mathbb{R}^{3}$  is 3-index,  $\mathbb{C}\Omega_{2}$ :

R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is methyl and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-pholyl;

R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is ethyl and K<sup>2</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-phenyl;

R<sup>1</sup> is -CH<sub>2</sub>-phenyl, R<sup>2</sup> is -CH<sub>2</sub>CF<sub>3</sub> and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-phenyl;

R<sup>1</sup> is -Crb-4-fluoro-phenyl, R<sup>2</sup> is methyl and R<sup>3</sup> is -CH<sub>2</sub>-O-CH<sub>2</sub>-phenyl;

 $-\mathsf{K}^1$  is -CH<sub>2</sub>-phenyl,  $\mathsf{K}^2$  is t-but, I and  $\mathsf{IC}$  is -CH<sub>2</sub>-C-CH<sub>2</sub>-phonyl; or

 $R^1$  is  $-CH_2$ -phenyl,  $R^2$  is methyl and  $R^3$  is  $-CH_2+O+CH_2+3$ ,4-di-fluoro-phonyl.

where the compound is 2-amino-regarded, and one appoind account of the where the compound is 2-amino-regarded, and the compound of 2-amino-regarded, and the compound of the proposition of the proposition of the compound of the proposition of the compound of the compound

25 ethyl]-2-methyl-propionamide.

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100. The compound according to claim 99 where the compound is 2-amino-N-[2-(3a-(R)-benzyl-2-methyl-3-oxo-2,3,3a,4,6,7-hexahydro-pyrazolo [4,3-c]pyridin-5-yl)-1-(R)-(3,4-difluoro-benzyloxymethyl)-2-oxo-ethyl]-2-methyl-propionamide.

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- 101. The compound according to claim 99 where the compound is the map (20 (0) the map (10 minutes) and 10 minutes (10 minutes) the map (20 minutes) and the map (20 minutes) and the compound is a compound in the map (20 minutes) and the compound is the compound in the compound in the compound is the compound in the compound in the compound in the compound is the compound in the co
- 104. A method according to claim 50 whorbin the disease or condition in
  - 105. A method according to claim 51 wherein the method is for accelerating the recovery of patients having undergone major surgery.
  - The tone fracture my fit.
- 15 107. A method for increasing muscle mass, which method comprises administering to a trump or other ability near 1 faunt for at most as a wide for compound of claim 1 which is effective in promoting release of endogenous growth hormone.
  - 108. A method for the treatment of osteoporosis according to claim 53 who ain the bisphosphonate companied is it and related.

  - 110. A method for promoting growth in growth hormone deficient children which comprises administering to a growth hormone deficient child a compound of claim 1 which is effective in promoting release of endogenous growth hormone.

# INTERNATIONAL SEARCH REPORT Int. .onal Application No

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# HP LaserJet 8150 series printer



Error:

Unable to collate job at printer

Reason:

Insufficient disk space for this job

Solution:

Ancrease the size of the printer's RAM distribution of an after a selection